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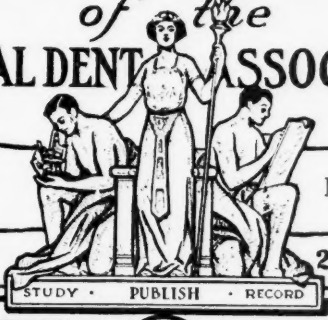

VOLUME VI NUMBER ELEVEN

$2.00 A YEAR 20 CENTS A COPY

NOVEMBER, 1919

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Why Gamble With Your Savings?—*Editorial.*

Special Announcement

Twenty-fourth Annual Session
Boston, Mass., 1920

CONTENTS

Page

Edward C. Rosenow, M. D. ..... Frontispiece

ORIGINAL COMMUNICATIONS.

Studies on Elective Localization: Focal Infection with Special Reference to Oral Sepsis.
By E. C. Rosenow, M. D. 983

Anatomical Measurements Relative to Conductive Anesthesia with Procaine and Alcoholic Injection for Tic Douloureux.
By William A. Cook, D. D. S. 1030

Chicago Dental Society.—President's Address.
By Victor H. Fuqua, D. D. S. 1039

Classification of Jaws and a Modeling Compound Technic.
By George P. Brenner, D. D. S. 1041

EDITORIAL DEPARTMENT.

Effects of Scorbutic Diet on the Teeth of Guinea Pigs 1058

Why Gamble with Your Savings When the Government Offers Ideal Investments 1060

ANNOUNCEMENTS.

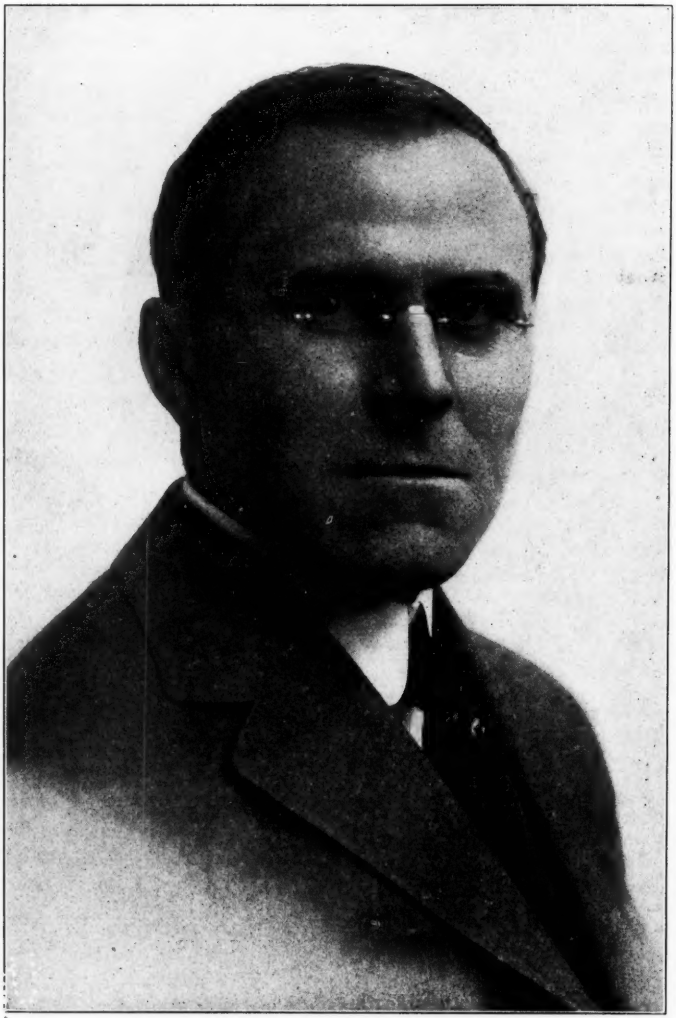
State Societies Meetings.—North Carolina State Board of Dental Examiners.—Bronx County Dental Society.—South Dakota State Board of Dental Examiners.—The Connecticut State Dental Commission.—Board of Dental Examiners of California.—Official Schedule of Michigan State Dental Examination Session.—Maryland Board of Dental Examiners.—Indiana State Board of Dental Examiners.—Marquette University Dental Alumni Association.—State of Nebraska, Department of Welfare 1062-1064

Dental Corps Orders from War Department 1064

ADVERTISING DEPARTMENT.

Index A-75

Classification Section A-71, A-73



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Rochester, Minnesota.

THE JOURNAL
OF THE
National Dental Association
VOL. 6 NOVEMBER, 1919 NO. 11

Original Communications.

STUDIES ON ELECTIVE LOCALIZATION: FOCAL INFECTION WITH SPECIAL REFERENCE TO ORAL SEPSIS.

By E. C. Rosenow, M.D., The Mayo Foundation, Rochester, Minnesota.

(Read before the Chicago Dental Society, Sept. 16, 1919.)

Introduction.

THAT foci of infection, often insignificant and symptomless in themselves, are a cause of systemic disease is indicated by many facts. Clinical studies have shown that focal infections are present in demonstrable form in a high percentage of the sick, including children. Thoro removal of foci of infection is followed by improvement in the general health and frequently by improvement or cure of distant local and systemic diseases, provided the changes are not too far advanced. Indeed, improvement has occurred so often that many physicians have come to regard these observations as proof of etiologic relationship, and if improvement does not follow the removal of a given focus it is considered presumptive evidence either that the particular operation was not properly performed or that other foci exist. Exacerbations of systemic conditions immediately following the removal of certain foci of infection further suggests causal relationship. The idea of an etiologic relationship is not new, and relief of systemic conditions following the removal of foci of infection is mentioned in the older medical literature.

Rush in 1801, cited by Duke, (10) after mentioning a number of striking cures which followed extraction of diseased teeth made the following statement: "I have been made happy by discovering that I have only added to the observa-

tions of other physicians, in pointing out a connection between the extracton of decayed and diseased teeth and the cure of general diseases." Miller (28) in 1889 demonstrated that infection of the mouth may cause constitutional disease. Pyorrhea is mentioned as a causative factor in pathologic conditions of the joints and tonsillitis as frequently accompanying rheumatic fever. Black (4) emphasizes the importance of dental lesions in ocular disease, and, in a review of the older medical literature, gives numerous instances indicating causal relationship between dental lesions, particularly in the form of alveolar abscess at the root apex, and pus pockets along the side of the root, to diseases of the eye. The relationship between ill health and infections of the mouth was thought in earlier years to be due chiefly to the swallowing of pus and of putrid material.

Notwithstanding the repeated suggestions of etiologic relationship, the medical and dental professions, as a whole, remained indifferent until Billings (2, 3) and his co-workers made their extensive clinical observations and correlated experimental studies in animals (7, 33) demonstrating the importance of septic foci, even when small, as a source of chronic infections conveyed by the blood stream. The broader conception of this interrelationship, well expressed by the term "focal infection," may therefore be regarded as having had its origin in recent years. The experimental studies included dental foci as well as localized infections in other parts of the body. As early as 1908 (33) endocarditis was produced by intravenous injection of the respective strains from a case each of staphylococcus and streptococcus virdidans endocarditis, which were clearly the result of dental infections. The combined clinical and experimental studies of Hartzell,(16, 17)Hartzell and Henrici, (18) Gilmer, (12) Gilmer and Moody, (13) and Moody (29) emphasized the importance of dental foci as sources of systemic infections. For a detailed consideration of results of numerous clinical and roentgenologic studies, and an exhaustive bibliography, Duke's (10) excellent monograph on this subject should be consulted.

Experimental studies have shown that foci of infection in a given case may harbor the same type of bacteria that is found in distant lesions; that intravenous injection of the freshly isolated strains both from the focus and from the diseased organs is followed by localization and lesions in organs corresponding to those involved in the patient from whom the bacteria were isolated; and, that from the lesions produced experimentally the organism may be isolated in pure culture, the disease again reproduced, and the organism again isolated. Moreover, immologic evidence indicating an intimate relationship is not lacking. The bacteria having elective localizing power may be agglutinated specifically by the serum of the patient. (5). In my own studies, the elective localizing power of the freshly isolated streptococci found in the focus or in systemic lesions has been demonstrated in appendicitis, ulcer of the stomach, cholecystitis, rheumatic fever, (36) erythema nodosum, (39) horpes zoster, myositis, chronic septic endocarditis, (34) epidemic paretitis, and acute anterior poliomyelitis, (40, 45). A fuller discussion of these studies may be found in the writer's original papers published in the Journal of Infectious Diseases and the Journal of the American Medical Association during the past four years. The results in ulcer have been verified in the main and extended by Helmholz (19) and Hardt, (15) and those in cholecystitis by Brown. (5). The elective localizing power of streptococci and colon bacilli from urinary infections has been demonstrated by Helmholz and Beeler. (20). A number of workers, on the other hand,

have failed to obtain evidence of the elective localizing power of streptococci or other bacteria isolated from foci of infection, and even of strains from the infected tissues.

In my own experiments in this field, the primary consideration was to determine whether or not foci of infection harber bacteria, quite without regard to species, which may produce the disease in animals corresponding to that found in the patient. Intensive effort was made to work with the bacteria from the depth of a focus and not merely with those on the surface which might be a saprophytic flora. Pus was expressed from tonsils, the pus in pyorrhea was aspirated from the depths of the pockets by means of a glass pipette, and studies were made on selected cases. Very early in the work it was found that the bacteria concerned were often extremely sensitive to oxygen, and that the property on which elective localization depends tended to disappear promptly, especially on aerobic cultivation. The specific strain may thus be lost even in the primary culture, unless the culture medium is particularly favorable for growth, both with regard to available nutritive material and with regard to oxygen tension. The importance of oxygen tension for the cultivation of various streptococci and the variations in this requirement for growth have been emphasized by Graf and Wittneben, (14) by Wherry and Oliver, (52) and by others.

The inability to obtain evidence of the elective localizing power of the bacteria in the hands of some observers, as pointed out by Gay, might well be explained by insufficient attention to technical details. Henrici, (18) for example, first plated his material aerobically on blood agar and then made inoculations in animals with subcultures of strains of streptococci fished from single colonies. In Moody's (29) experiments the dose was very much smaller and the animals were allowed to live for a longer time than in my experiments. As to the general disease-producing power of streptococci and other bacteria contained in dental and other foci, however, the experimental results of all workers are more in accord. Thus, Henrici produced myositis, nephritis, myocarditis, arthritis, and arteritis with cultures from dental foci. Moody obtained similar results.

Many facts suggest that dental infections are often metastatic from foci elsewhere than in the dental area (40). The observation which I have made, that bacteria isolated from the tissues in metastatic lesions show a greater affinity for that tissue than those from the primary focus, seems to indicate that the repeated occurrence of the same type of lesion, such as pulpitis in a given case, may be the result of a blood-borne infection from one pulp to another, as well as from infection from a focus in the tonsil or elsewhere. The rather common occurrence of pulpitis during or following certain epidemics of acute respiratory diseases is in harmony with this idea. That infection of the pulp may be metastatic is shown by the fact that it occurs in sound teeth, that apical abscesses are sometimes found at the roots of otherwise normal teeth whose pulp chambers have not been perforated either by treatment or decay, and that infection is occasionally found in unerupted teeth. Moreover, direct experimental evidence that this may occur has been obtained. In a previous communication, I have shown the affinity for dental pulps and dental nerves in animals of a streptococcus isolated from the foul pulp of the tooth of a person in whom infection of a number of pulps subsequently occurred.

I shall now outline a method for a bacteriologic and experimental study applicable to dental problems, record further data concerning the localizing power of bacteria isolated from various

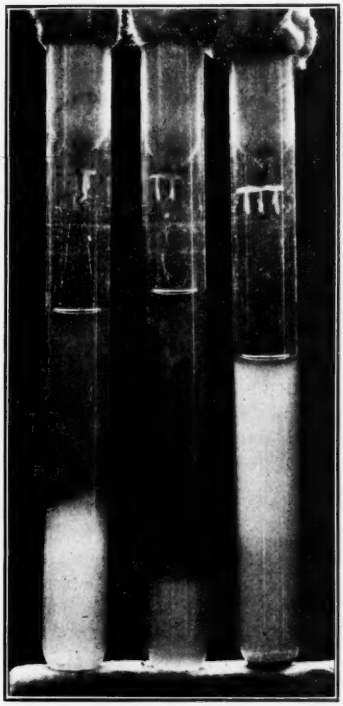
dental foci of infection, report detailed experiments in a few illustrative cases, and present certain deductions which may serve as useful guides in various dental procedures.

The solution of many dental problems will depend, to a large extent, on bacteriologic studies. The usual, altho standard, methods are not always sufficient. The methods should be adapted to the special conditions in this field. Streptococci and other bacteria in tissues and in chronic foci of infection, particularly those about teeth, are often extremely sensitive to oxygen. Many bacteria require partial oxygen tension and do not grow under strictly anaerobic or aerobic conditions (36). Aerobic cultivation of those less sensitive tends to destroy the property on which elective localization depends. The amount of material obtainable for inoculation and the number of bacteria in many cases of dental infection is small, and hence particularly adaptable mediums are indicated. The method of making the primary cultures should be simple so that it can readily be applied with little annoyance to the patient and operator. A method embodying the above requirements, and similar to one I have described previously, (37) has proved useful in studying the bacteriology and the localizing power of the bacteria isolated in various dental infections:

Method For The Bacteriologic Study of Dental Infections.

Two mediums, dextrose-brain broth and soft dextrose-brain-agar, have been found especially useful. They are prepared from meat infusion or beef extract in the usual way, and titrated so that the final product is from 0.5 to 0.7 acid to phenolphathalein and of a hydrogen ion concentration of from 7.2 to 7.6. In order not to interfere with the growth of sensitive bacteria and yet to indicate their number, the agar medium is made to contain only 0.5 per cent of agar, just sufficient to jell instead of the usual 1.5 or 2 per cent. Both of these mediums are placed in test tubes so that the column of medium is at least 8 cm. tall. Pieces of fresh brain substance, equivalent to about 1 gm., are added to the bottom of each tube to make the column approximately 10 cm. tall. The mediums are then sterilized in the autoclave at 15 pounds pressure for fifteen minutes, or in the Arnold sterilizer on three successive days. Dextrose, from a concentrated sterilized solution, is added to both mediums after sterilization to make them 0.2 per cent dextrose, and decolorized acid fuchsin (Adraid's indicator). The addition of ascites fluid blood or serum just before use, while useful in special instances, is found unnecessary for routine work. The brain substance renders the bottom of the tube anaerobic, the top necessarily is aerobic and it follows that every gradation of oxygen pressure occurs between these two points. The growth in the liquid mediums almost invariably begins in the bottom of the tube and then forces its way upward, in some instances to the top of the medium within 24 hours, in others, in 48 or 72 hours, or not at all. (Text Fig. 1). Tall tubes of broth, made from meat infusion in the usual way, to which 5 per cent blood is added and 0.5 per cent dextrose from a concentrated solution just before use, have proved especially useful in studying the localizing power of bacteria from dental foci. The liquid mediums are especially useful for studying the localizing powers of the primary culture, but they give little indication as to the number of bacteria present in the material inoculated, and one contaminating organism from the air or elsewhere may outgrow the more parasitic organisms contained in the material under consideration. The agar medium in conjunction with a study of smears of the material inoculated furnished quite accurate information as to

the number of bacteria contained in the material inoculated and should be used as a control of the liquid medium. In the agar medium contaminating bacteria do not outgrow those contained in the material inoculated. The bacteria live for a long time, and the properties on which elective localization depends may be retained in the deep colonies for a longer period than when grown aerobically so that transfers to the liquid mediums for animal injection may be made at a considerable period after growth has occurred. The material from a foul pulp or a dental canal may be inoculated directly with a broach; effort should be made to carry some of it to the deeper layers of the mediums. A granuloma or other material from apical infections may be emulsified in sodium chloride solution in a mortar in the specially devised sterile air chamber and then inoculated, or it may be dropped into the broth directly. Transfers from these mediums to blood agar or other mediums may be made for identification and for other studies.



Text Figure 1.

Photograph of broth cultures, illustrating the importance of the use of tall columns of media in connection with dental infections. Tube I: Dextrose-acacia-broth inoculated with infected pulp of tooth in a case of iritis (Case 3458). Tube II: Dextrose-acacia-broth inoculated with the iris of rabbit showing iritis, following injection of culture from the apex of the same tooth. Tube III: Dextrose-blood-broth inoculated with the iris of the rabbit showing iritis. The growths in Tubes I and II remained limited to the lower portion of the tubes for seventy-two hours; the growth in Tube III was limited to the lower portion for forty-eight hours, and then forced its way to the top during the third twenty-four hours. Aerobic blood-agar-plates of Tubes I and II, were negative, while III showed a pure culture of streptococcus viridans.

In the removal of teeth some danger of contamination with the mouth flora exists even when extreme measures are adopted in sterilizing the gum margins. This danger becomes slight in proper hands, and if the agar medium yields many colonies one may be sure that the bacteria were contained in the material inoculated. If few bacteria exist in the tissue, as may be the case in chronic granuloma, control cultures in the agar medium of the material contained in the pulp chamber of abscessed teeth, for example, should always be made. This may be done conveniently by sterilizing the surface of the tooth in a Bunsen flame or by dipping it in alcohol and burning the alcohol, care being taken not to overheat and thus kill the bacteria in the pulp. If cultures can not be made immediately, the tooth should be wrapped in dry sterile gauze; it should not be placed in sterile salt solution or other liquids as is so often done. The pulp chamber may be entered from the seared apical end with the aid of a flamed dental drill, or by splitting the tooth wrapped in sterile gauze in the jaws of a rigid vise. Moreover, the presence of

the bacteria is readily demonstrated by incubating the granuloma or other tissue in the depths of the medium for from eight to twelve hours, fixing the tissue in 10 per cent formalin, and cutting and staining sections. At the point where living bacteria occur a colony containing many bacteria is formed and, owing to the density of tissues, it is readily demonstrable microscopically. This procedure has the advantage of showing the location of the bacteria in their relation to the blood-vessels. (Figs. 5, 6, 9, 10, 11, 12, 13, 16, and 17).

For details regarding inoculations of animals, reference should be made to the original papers on elective localization. Suffice it to state here that inoculations in animals should be made intravenously, altho specific localization has been obtained in some instances following intraperitoneal inoculation. The culture to be injected should be mixed so that the bacteria grown at the different levels are included. Control cultures of the material injected should always be made since the freshly isolated organisms tend to die quickly, and a negative result may be due to this cause. At least two animals, preferably medium-sized rabbits, should be inoculated with a given culture, one with a relatively small dose (1 to 5 c.c.) the other with a large dose (5 to 10 c.c.). The dose in special instances may be made smaller or larger, depending on the type of bacteria at hand. If the bacteria are separated from the broth and suspended in salt solution the dose should be increased. The animals should be anesthetized in from forty-eight to seventy-two hours after injection, and examined carefully in a bright light for lesions. Animals seemingly well have frequently shown specific lesions. Repeatedly negative results have been reported by the inexperienced investigator when unmistakable lesions were found on closer examination, especially in the case of experiments in myositis and arthritis. Cultures and sections from the lesions should, of course, be made to determine the identity of the causative organisms, especially if the primary mixed cultures are injected. The nonpathogens disappear from the circulation and the tissues with remarkable rapidity, and the specific organism quickly localizes and produces lesions. The animal often serves as an efficient plating, separating the pathogens from the nonpathogens. This fact was emphasized some years ago when it was shown that streptococcus viridans from endocarditis was isolated in pure culture from lesions in the heart valves, and hemolytic streptococcus was isolated from the turbid point fluid in animals after mixtures of the two strains had been injected intravenously.

Localization of Bacteria from Dental Foci of Infection.

In Table 1 is given a summary of results obtained in animals injected intravenously with cultures obtained from dental foci. The figures indicate the percentage incidence of lesions in various organs as revealed by necropey. In cases in which lesions were not found blanks are left in the table, altho in some instances lesions would no doubt have been found if sufficient time had been available to make a complete search. Owing to the frequency with which colon bacilli contaminate primary cultures from pyorrhea pockets, some of the cultures injected had been plated on blood agar. On analysis, this was found to be the reason for the relatively low total incidence of elective localization in some of the diseases studied. In instances in which the primary cultures were injected, the tendency to localize electively was usually well marked. Only one culture was made in each case. It was not intended to obtain a culture from the focus at any particular time, as during an exacerbation of symptoms, altho cul-

TABLE I.

Localization of Bacteria from Dental Foci of Infection.

Diseases	Strains (42)	Animals injected (156)	Percentage of Animals Showing Lesions in: Eyes	Teeth	Skin	Lymph Glands	Thyroid	Muscles	Joints	Intestines	Appendix	Stomach (Hemorrhage)	Stomach (Ulcer)	Duodenum (Hemorrhage)	Duodenum (Ulcer)	Gall Bladder	Pancreas	Spleen	Adrenal	Kidney	Bladder	Thymus	Lungs	Pericardium	Myocardium	Endocardium	Nerves	Ganglia	Meninges	Spinal cord	Brain
Myositis and Chronic Arthritis	17	62	9	11	2	2	3	47	26	2		9	5			9		5	2	14		5	10	10	16	22	12			2	2
Ulcer	6	24						8	6	4		46	38	8	13	13			4				8	4							
Appendicitis	1	1									100	100																		
Neuritis	3	12						42	16	16										16	8		16	8	16	8	68	8			
Herpes Zoster	4	16	13	25	19	13	6	25	31			6	6			6	6	13		13			25	6	6	6		39	19		6
Multiple Sclerosis	5	12			8			25	17	8		8	8							17			8		8		8			18	33
Transverse Myelitis	2	15							7	13	7	27		7		7.				7							7		7	20	27
Goiter	3	9					44	11	33			11				11				11		11	11		22						
Keratitis and Iritis	1	5	60	60		20	20	60	40	20	20			20								20				20	60				

TABLE 2.

Localization of Bacteria in Pus Expressed from Tonsils and in Emulsions of Extirpated Tonsils Directly Injected Into Animals.

Diseases	Strains (44)	Animals injected (71)	Percentage of Animals Showing Lesions in: Tongue	Teeth	Skin	Thyroid	Muscles	Joints	Periosteum	Intestines	Appendix	Hemorrhage Stom.	Ulcer Stomach	Hemorrhage Duodenum	Gall Bladder	Adrenal	Kidney	Lungs	Pericardium	Myocardium	Endocardium	Nerves	Ganglia	Meninges	Spinal Cord	Brain
Chronic Arthritis and Myositis	24	37		5		5	62	43	3	5		10	3				15	15		10	15			5	
Ulcer of Stomach	4	5			20		40					80	80	40							20					
Cholecytitis	1	2										50	50	50	50						100					
Nephritis	2	2										50					100									
Neuritis	4	8		13			25					13										50				
Herpes Zoster	3	7	14		43		29	14										14					29			
Neuralgia	1	3						33			3					66	66	33			33	100		33		
Multiple Sclerosis	4	6															17	17	34					17	17	
Erythema Nodosum	1	1			100		100																			

tures happened to be obtained during such periods in some instances. The table records the results obtained from injecting 151 animals with cultures from forty-two cases. The incidence of lesions in the organs or tissues in the animals corresponding to those involved in the patient was relatively high in myositis and dental neuritis, ulcer of the stomach, appendicitis, neuritis, herpes zoster, multiple sclerosis, transverse myelitis goiter, and iritis. In some cases the tendency of the streptococcus to localize electively was very striking, there being no lesions in other organs, while in other cases there were minor localizations in addition to specific localizations, indicating both a general and a specific virulence. In some the results were entirely negative. This was the case following injection of streptococci after aerobic plating on blood agar.

Localization of Bacteria in Pus Expressed From Tonsils and in Emulsions of Extirpated Tonsils Directly Injected into Animals.

Some years ago, in studying the localizing power of the bacteria contained in tonsils in cases of rheumatic fever, "emulsions of freshly removed tonsils were found to be very toxic for rabbits, guinea-pigs, and dogs. Symptoms following injections of relatively large doses in guinea-pigs and dogs are those characteristic of anaphylaxis in each. The degree of toxicity was greatest in the emulsions from tonsils which were visibly infected and which showed the greatest numbers of bacteria in plate cultures (35)."

Dick and Burmeister (9) made a more extensive study of the toxicity of extirpated tonsils; they found also that the toxicity is in proportion to the amount of evidence of infection, particularly by hemolytic streptococci. These experiments indicate that ill effects must come from the continued absorption of toxic material from localized infections aside from the actual localization and growth of living bacteria in distant organs or tissues.

Those who are inclined to minimize the importance of foci of infection as causes of systemic disease have raised the objection that in animal experiments repeated large doses of cultures are given intravenously, and that therefore localization is to be expected, but that under natural conditions this does not occur. It is a fact that elective localizations have occurred in instances in which the dose of the culture injected was very small and they have occurred even following intraperitoneal injection. But in order to simulate the conditions more closely direct injections of bacteria that had grown in the tonsils have been made in suitable cases together with cultures made from this material.

In Table 2 is given a summary of these experiments. The figures indicate the percentage incidence of localization in the various organs as revealed to the naked eye at necropsy. The blank spaces indicate the absence of lesions in these organs. Most of the animals were injected intravenously directly with a small amount of material expressed from tonsils after it had been emulsified in salt solution. The rest were injected with small doses of emulsions from tonsils. The tendency to localize electively in the organs or tissues corresponding to those involved in the patients from whom the material was obtained was often a striking picture. This was particularly marked in cases of chronic arthritis and myositis when a number of experiments, sufficient to be of value, were made, altho even when only a few animals were injected from cases of ulcer of the stomach, nephritis, neuritis, and orythema nodosum, localization occurred in the specific organ more often than in other tissues and the lesions

were more distinct. The tonsils showing the largest amount of infected material are often small and atrophic. There is little evidence of inflammatory reaction. The infection is virtually outside the tonsil in walled-off pockets and hence localization in the tonsils of animals should not be expected on intravenous injection. Besides, the tonsils of the animals used bear little resemblance to the human tonsil.

The fact is now well known that acute exacerbations in symptoms follow the surgical removal of certain foci of infection in chronic diseases, especially those about the teeth. This is particularly likely to occur in persons with chronic disorders, who appear to be hypersensitive. The danger from the removal of too many foci at one time, in these cases, was noted some years ago (1913) when a fatal exacerbation following the removal of and curettement of a number of abscessed teeth occurred in a patient suffering from chronic arthritis. To quote (39):

> "On February 6, 1913, tonsillectomy was followed by slight increase in temperature for a day or two. On February 16, a number of teeth were extracted, followed on the next day by fever from 102 to 105 F. for nearly three weeks, associated with pericarditis, pleurisy with effusion, bronchopneumonia, exacerbation of the joint sensitiveness, and successive crops of arythematous nodes of the skin chiefly over the fore-arms and legs, acute dilatation with acute multiple ulceration of the stomach shortly before death, February 28."

The Sockets Were Curetted Immediately After Extraction.

The importance of the gradual removal of foci, particularly in the dental area, in chronic diseases has since been emphasized especially by Hartzell, (17) by Thoma, (49) and by many others. The exacerbations may be due to the absorption of toxic material to which these patients are hypersensitive, to a lighting up of a more or less dormant infection in metastatic lesions, or to a localization of bacteria that gain entrance thru the traumatized area from which the diseased tissue may have been only partly removed. That such localization occurs in some instances is indicated by the results obtained in the case quoted above, and by the fact that the bacteria contained in the material expressed from tonsils or contained in extirpated tonsils, in some persons who developed temporary exacerbations, showed elective localizing power in animals. Thus, a patient with simple thoracic herpes zoster developed a gangrenous herpes zoster following the expression of pus from the tonsils containing bacteria that produced herpes in animals.

Illustrative Cases and Experiments.

Case, 516, a woman aged 57, with typical transverse infectious myelitis, examination showed marked pyorrhea. The patient had but seven teeth remaining, and these were loose in their sockets and surrounded by a large amount of pus. A moderate amount of pus was expressed from the tonsils. Twenty-one animals were injected with the bacteria isolated from the pyorrheal pockets and tonsils of this patient. Fifty per cent of the animals developed lesions in the meninges and sixty-six per cent showed lesions in the spinal cord. Partial or complete paralysis which began in the hind extremities developed in many of the animals. Lesions in the cord consisted chiefly of hemorrhages both in the gray and white matter, and of leukocytic infiltration in the meninges and surrounding the blood-vessels. The results following the injection of cultures from the pus about the teeth were similar to those in the following experiment:

Rabbit 514 was injected intravenously

Oct. 31, 1915, with the growth from 60 c.c. of ascites-dextrose broth. November 1, peculiar incoordination was noted. The animal threw itself from side to side in attempting to get on its feet, which it was not able to do on account of weakness in the hind extremities. It was extremely ataxic, and was unable to maintain its equilibrium. The respirations were increased and it responded only slightly to a pin-prick in the hind extremities. November 2, the animal was found dead. Necropsy showed marked edema and hemorrhage of the pia. A blood-clot was found between the cerebrum and cerebellum. The external surface of the dura showed marked congestion and numerous hemorrhages. The spinal fluid was turbid and hemorrhagic. There were a few small hemorrhages in the gray matter of the cerebrum and a large number in the cerebellum. Cultures of the blood, spinal fluid, brain, and cord contained short-chained streptococci and a few colon bacilli. The meninges of the cervical cord showed marked leukocytic infiltration, especially around the nerve roots, but the nerve substance was free from infiltration. The infiltrating cells were chiefly polymorphonuclear leucocytoses. The medulla showed marked hyperemia of the vessels but no hemorrhagic nor leukocytic infiltration of the dura. Gram-positive diplococci were found in and adjacent to lesions, but not in tissues free from lesions.

Case 595, a middle-aged man, with typical multiple neuritis which had followed an attack of so-called influenza three months before. The details of this case are reserved for a report elsewhere. The patient's tonsils appeared quite normal on the surface but a moderate amount of pus was expressed from the poles of each. The teeth and gums were believed to be normal, and they appeared so on the surface, but on closer examination a marked pyorrhea was found about several of the molars. Two series of nineteen animals were injected with cultures from tonsils and teeth, and lesions of the peripheral nerves occurred in 79 per cent. The results in animals injected with cultures from the pyorrheal pockets are illustrated in the following protocols:

Rabbit 739, weighing 2,115 gm., was injected intravenously March 13, 1916, with a growth from 7.5 c.c. of ascites fluid. March 14 the animal was found dead. At necropsy, marked hemorrhagic infiltration of the right musculospiral nerve, acute splenitis, and several small areas of hemorrhage in the stomach were found. Numerous cross sections of brain and cord showed no lesions. The localization in the musculospiral nerve is illustrated in Figure 35-A.

Rabbit 746, weighing 1,240 gm., was injected intravenously March 17, 1916, with 10 c.c. of ascites fluid culture. March 19 the animal was found in a crouched position; it was disinclined to walk; it was lame in the left hind extremity which it held up as if it were painful. Its hair was fluffed. March 23 the symptoms were about the same. The animal was chloroformed, and at necropsy showed a large number of white lesions in the muscles, arthritis of both knees, hemorrhage, edema, and infiltration of both tibial nerves, most marked in the upper third of the left, and localized infiltration and edema adjacent to and involving the small branches of the subcutaneous nerves in various parts of the body. Blood-agar plate cultures of the blood were sterile.

Guinea pig 156, weighing 320 gm., was injected intraperitoneally March 17, with 5 c.c. of ascites fluid cultures. March 18 the animal was found dead. Necropsy showed acute peritonitis and marked hemorrhage and edema of the lower end of both posterior tibial nerves. The lesions and localizations are illustrated in Figures 31 and 35-D-E.

Guinea pig 158, weighing 330 gm., was injected intravenously March 23, with 3 c.c of ascites-dextrose-broth culture after the strain had passed thru one animal. March 24 there were no symptoms. The animal was chloroformed, and at necropsy were found swelling and hemorrhagic infiltration in a localized area in the external and internal left popliteal nerves, in the lower third of the right sciatic nerve, in the right anterior crural nerves, in two of the trunks on both sides of the sacral plexus, and in the anterior trunk of the right brachial plexus. Cultures in ascites-dextrose on blood-agar plates of the blood, kidney, muscles, and cord, proved sterile. Cultures of the liver showed ten colonies of streptococci. Ascites-dextrose-agar shake cultures of the cord, kidney, and normal trunk of the sacral plexus remained sterile, while those of the liver showed two colonies, and those of the muscle, one colony of streptococci. The type of lesions in the nerves and the localization of the bacteria are illustrated in Figures 32 and 35-B.

Case 621, a woman aged 53, with chronic multiple arthritis and myositis. Twenty years before, the patient began to have pain in the right shin just below the knee, soon after a pregnancy. This was temporarily relieved by hot baths, but later pain and stiffness developed in the knee, and with it pains passing from joint to joint. A vaccine prepared from streptococcus rheumaticus was used, and potassium iodid was administered, resulting in great improvement which lasted for two years. The patient then developed pain in the jaws and teeth and the joint symptoms returned. An x-ray examination disclosed abscessed teeth which were removed. The tonsils had been removed seven months before with some improvement. A general examination revealed multiple arthritis in all the large joints with marked destruction of joint surfaces, as shown by the x-ray, ankylosis of the knees, and almost complete fixation of both elbows. A small amount of infected lymphoid tissue in the region of the tonsil scars was found and removed. X-ray examination revealed rarefaction around the apices and roots of the first left upper molar. This tooth was extracted. Small masses of connective tissue over the apices of the roots and a partially calcified pulp were found. Improvement in the patient's condition following the removal of these foci was slight and temporary; this could be expected considering the marked changes that had already occurred. Cultures from the granuloma of the extracted tooth in dextrose-broth yielded a large number of green-producing streptococci and a few hemolytic streptococci, while those made from the pulp contained pure cultures of green-producing streptococci. Those from the tonsils showed green-producing streptococci, micrococcus catarrhalis, straphylococci, and small Gram-positive bacilli. The primary cultures in dextrose-broth of each were injected into four animals. Non-suppurative arthritis, lesions in the ligaments and the periosteum around joints and muscles, chiefly in the tendinous portion, were the predominating findings in all the animals. The two injected with the culture from the pulp also showed lesions in the pulps of teeth, while the two injected with the culture from the granuloma and tonsil, respectively, did not.

Rabbit 813, weighing 1,750 gm., was injected intravenously April 27, 1916, with 10 c.c. of ascites-dextrose-broth culture from the apex of the extracted tooth. April 28, when the animal seemed quite well, it was chloroformed. Examination revealed a large hemorrhage in the periosteum on the inner aspect of the tuberosity of the left tibia, slightly turbid fluid in both knee-joints, a number of hemorrhages in the muscles and tendons about the hip-joints, a moderate

number of small whitish streaks in the flat muscles about the chest and diaphragm and over the tendinous portions of the muscles of the extremities. There were two hemorrhages in the tricuspid valve, two small ones along the lesser curvature of the stomach, and a large hemorrhagic ulcer near the pylorus. There were no other lesions. Blood-agar plate cultures from the blood and joint fluid were sterile, while cultures in ascites-dextrose-broth showed green-producing streptococci.

Rabbit 814, weighing 1,210 gm., was injected intravenously April 27, 1916, with 10 c.c. of ascites-dextrose-broth culture from the pulp of the extracted left upper molar. April 28, the rabbit seemed quite well; it was chloroformed, and at necropsy distinctly turbid fluid in both knee-joints, a few hemorrhages in the capsule and muscles around the left knee-joint and left shoulder-joint, a few lesions in the muscles, especially in the tendinous portions about the extremities, and hyperemia and hemorrhages in pulps of teeth were found.

Rabbit 820, weighing 1,240 gm., was injected intravenously April 28, 1916, with the growth from 30 c.c. of ascites-dextrose-broth culture from the pulp of the extracted tooth. April 29 the rabbit seemed in pain and its muscles were sore. It was chloroformed and at necropsy a number of hemorrhages in the periosteum near the tuberosity of the tibia, and marked hyperemia and small hemorrhages of the pulps of the teeth were found.

Rabbit 823, weighing 1,420 gm., was injected intravenously April 29, 1916, with 10 c.c. of ascites-dextrose-broth culture from the tonsil. May 1, the rabbit seemed quite well but was distinctly muscle-sore. The animal was chloroformed. A small number of lesions in the muscles about the knee and hip joints, especially in the tendinous portions, arthritis of the left knee, hemorrhages in the periosteum of the lateral aspect of the tibia, and hemorrhages in the periosteum under the left eye were found.

Case 623, G. W., middle aged physician, had repeated attacks of pain in the right gluteus maximus muscle, and occasional stiffness of the back muscles. The attacks varied from time to time and were much less severe after the removal of the tonsils at the end of three years, but they recurred at intervals and the patient was not quite free from stiffness and soreness in the interim. On examination at the Mayo Clinic, in April, 1916, a small abscess was found over the apex of a tooth, which was extracted. Slow but continuous improvement followed, with entire freedom from severe attacks for several years, even during ten months in the damp, cold climate of France. A small granuloma was found over the apex of the root of the extracted tooth and the canal showed a calcifying pulp. The cultures from both showed short-chained, green-producing streptococci, a few staphylococci, a few hemolytic streptococci, and a moderate number of slightly hemolyzing streptococci. A primary culture of the calcified pulp was injected into one rabbit, the primary culture of the granuloma into another. The results obtained from the injections are recorded in the following protocols:

Rabbit 818 was injected intravenously April 28, 1916, with the growth from 30 c.c. of ascites-dextrose-broth from the granuloma. April 29, the animal seemed muscle-sore but otherwise well. It was chloroformed and at necropsy the fluid in knee-joints and shoulder joints was found distinctly turbid. The right gluteus muscle was streaked with white and was hemorrhagic, and an area, almost 1 cm. in diameter, near the attachment of the muscle to the ilium contained numerous small hemorrhages. A

moderate number of lesions were scattered in the more tendinous portions of the muscles thruout the body and in the muscles about the shoulder blade. Cultures from the blood and joint fluid showed a pure culture of green-producing streptococci, those from the muscle a large number of slightly hemolyzing streptococci, a few green-producing streptococci, and a few Gram-negative bacilli. The microscopic appearance of the lesions in the gluteus maximus muscle and the localization are illustrated in Figures 28 and 33-D.

Rabbit 822, weighing 1,220 gm., was injected intravenously April 29, 1916, with 10 c.c. of ascites-dextrose-broth culture from the partially calcified pulp of the extracted tooth. At 3 P. M. the rabbit was found dead. Examination revealed numerous small hemorrhages over an area 1 cm. in diameter in the right gluteus maximus muscle near its attachment to the ilium. A group of hemorrhages in the other muscles about the right hip joint and a few lesions in the muscles on the right side of the chest were found. Cultures of the blood were sterile.

Case 628, a woman, aged 54, had suffered from severe shooting pain in the lumbar region and back, and down the right leg to the inner side of the knee, for a period of three or four weeks fifteen months before. She had had an acute attack of cystitis eighteen months before, at which time the course of the nerve on the inner aspect of the leg was eruptive and blistered. Five months before coming to the clinic the patient had an attack, less severe, lasting three or four weeks, and during the previous winter weakness in the back and numbness in both thighs had been noted. X-ray examination of the lumbar spine was negative; the joints showed ankylosis. Abscesses were found at the roots of the lower right third molar and second bicuspid. The tonsils which showed moderate infection were removed. The teeth were extracted. Cultures from the tonsils showed hemolytic and green-producing streptococci, and cultures from the small abscess at the apex of the molar showed a pure culture of green-producing streptococci in pairs and in long and short chains. The root-canals were almost obliterated; neither of them were foul. Cultures from the tonsils, from the small granuloma at the apex of the molar, and from the pulp of the bicuspid, were injected into animals. The following protocols illustrate the marked tendency to localize in the lumbar nerves and dorsal roots and ganglia:

Rabbit 839 was injected intravenously May 20, 1916, with 10 c.c. of ascites-dextrose-broth culture from the granuloma at the apex of the molar. May 21 the animal was found dead. Necropsy showed a number of punctate hemorrhages in the nerve substance of the left external popliteal nerve and its branches to the calf of the leg. The nerve sheath was hyperemic and also showed hemorrhages. In the left sciatic nerve was one small punctate hemorrhage; in the right sciatic nerve a few hemorrhages, and one small hemorrhage was found in the right posterior tibial nerve. Very small punctate hemorrhages dotted the skeletal muscles. The external dural venous plexus was hyperemic. The spinal roots and the membranes of the cord were free from hemorrhages, except for a sharply circumscribed subpial hemorrhage 3 mm. by 4 mm. surrounding the right second sacral anterior root, and one smaller hemorrhage surrounding the nerve just beyond the ganglion of the third sacral root. Numerous cross sections of the cord showed no lesions in its substance. Cultures from the blood showed pure culture of short-chained streptococci.

Rabbit 842 was injected intravenously May 22, 1916, with 10 c.c. of the ascites-dextrose broth culture from

the pulp of the lower right third molar. May 23 the animal seemed well; the injection was repeated. May 25 it seemed well and was chloroformed. Necropsy revealed a few lesions of the muscles over the left hip and psoas. Distinct hemorrhagic edema surrounded the posterior roots of the fourth left cervical and third and fourth left dorsal ganglia, and the extradural vessels in the lumber region were markedly congested. Numerous cross sections of the brain and cord showed no lesions. Cultures of the blood in ascites-dextrose broth showed a pure growth of streptococci.

Rabbit 845 was injected intravenously May 24, 1916, with 5 c.c. of ascites-dextrose-broth culture of the streptococcus isolated from the rabbit injected with the primary culture from the tonsil. May 26, the animal moved about as if in pain; it was chloroformed and at necropsy a few small hemorrhages in the bladder, a few white embolic foci in the cortex of the kidney, localized myocarditis, arthritis of both knee-joints, a few lesions in the muscles, and localized areas of hemorrhage and edema of the sheaths of the main trunks of the lumbar plexus were found. (Fig. 21). There was one area of hemorrhage and infiltration in the right external popliteal nerve, and also hemorrhagic edema of the external surface of the dura posteriorly and surrounding the posterior dorsal roots, chiefly in the curvical region.

Case 630, a druggist aged 46, had had two attacks of epilepsy in the six weeks before his examination, and red spots had appeared on the forehead and to the right of the midline, extending back over one-half of the right side of the head. One week later, he began to suffer severe pain in the region of the right eye. A typical herpes zoster was found over the right side of the face and forehead. The tonsils were moderately infected, an x-ray examination of the teeth revealed an abscess at the roots of the lower left molar. The tonsils were removed, and the tooth was extracted. A series of five rabbits was injected with cultures from both. Four rabbits were injected with cultures from the tonsils before and after one animal passage; all showed herpes. The result in the rabbit injected with the culture from the granuloma at the apex of the tooth was as follows:

Rabbit 843, weighing 1,160 gm. was injected intravenously May 23, 1916, with 10 c.c. of ascites-dextrose-broth culture. May 26, the animal sat around as if in pain; it was chloroformed, and at necropsy numerous small vesicles with opaque bases on the dorsum of the tongue, chiefly on the left side, were found. The vesicles were not ruptured and were from 0.5 to 2 mm. in diameter. The right gasserian ganglion showed a number of subcapsular hemorrhages, and a few hemorrhages were found in the valves of the heart. No lesions were found in the numerous cross sections of the brain and cord. Cultures from the blood in ascites-dextrose both showed streptococci.

Case 674, a man aged 53, had suffered from typical bilateral trigeminal neuralgia for twenty years.* The patient's tonsils were of moderate size, red, and contained a small amount of pus. Many of his teeth had been extracted, and the gums were retracted from those remaining. Pyorrhea was marked. Cultures from the pus expressed from the teeth and tonsils were injected into animals. The results are illustrated in the following protocol:

Rabbit 908 was injected intravenously July 12, 1916, with the growth from 30 c.c. of ascites-dextrose-broth culture from pus from around the teeth. July 14 the animal was found dead. Necropsy revealed a large hemorrhagic edematous area surrounding the right inferior

*The details of the history are reserved for a more complete report elsewhere.

dental nerve at the point of exit; a few distinct hemorrhages in the nerve sheath; a large hemorrhage and marked edema of the right superior dental nerve, extending for a distance of 1 cm. in the bony canal; multiple hemorrhages and hyperemia of the left inferior dental nerve within the submaxillary bone; and marked hyperemia, but no gross hemorrhages in the pulp of the teeth in the left lower jaw. The culture injected contained streptococci and a Gram-negative bacillus. Blood-agar plate culture of the blood after death showed a few streptococci and a moderate number of Gram-negative bacilli. Microscopic sections were made of the sensory root of the right gasserian ganglion, of the left inferior dental nerve, of the tooth pulp, of both superior maxillary nerves, and of the gasserian ganglia. The lesions and localizations found in these areas are shown in Figures 29 and 34, A and B.

Case 3368, a man aged 47, woodmaker by occupation, complained of feeling below par generally, and of recurring mild attacks of rheumatic pains in back, arms, shoulders, and thru the head. The attacks tended to recur at intervals of about one month for the past three or four years. The patient also complained of a burning sensation in the mouth. A general examination was negative, cystolic blood pressure 136, diastolic pressure 66, Wasserman test negative. An x-ray examination of the head showed cloudy maxillary sinuses, and apical rarefaction about three teeth. The first right upper bicuspis gave no evidence of rarefaction over the apex, but was somewhat discolored, and an electric test indicated lost vitality of the nerve. The four teeth were extracted, and the bicuspid was sent for cultures by Dr. Gardner. No evidence of infection over the apex was found. The surface of the tooth was sterilized in a Bunsen flame, wrapped in sterile gauze and spilt open in the jaws of a vise. The pulp appeared quite normal, altho it was slightly hyperemic, particularly over a small lateral area. After the surface of a blood-agar plate had been inoculated, the pulp was placed in the bottom of a tall tube of dextrose-acacia-broth, and incubated for 10 hours. It was then placed in 10 per cent formalin. A pure culture of a short-chained streptococcus developed in the broth; it showed preference for anaerobic conditions, growing only in the lower two-fifths of the column of the broth. (Text Fig. 1, Tube I). Microscopic examination of stained sections of the pulp showed practically no abnormalities except a small area of round cell infiltration along one margin. (Fig. 12). Sections of the pulp, after incubation in the broth for 10 hours, showed a number of capillaries plugged with streptococci, (Fig. 12), together with large numbers of bacteria in the area of infiltration. (Fig. 13). The primary broth culture was injected intravenously into two rabbits. The one developed marked double iritis, hemorrhage and infiltration in the pulps of teeth, and a number of hemorrhages in the muscles. The rabbit which received a smaller dose showed symptoms of iritis, injection of vessels, photophobia, and lacrimation for a number of days and then recovered. The animal was anesthetized on the third day. Slightly turbid fluid in the knee joints was found, but no other lesions. Cultures from the iris of the rabbit showing marked iritis (Text Fig. 1, Tube III) were injected into two rabbits. Both of these developed temporary symptoms of iritis. One had outspoken lesions of the pulps of the teeth, and both had lesions in muscles and joints. One also had hemorrhage in the stomach and heart valves. The following experiments illustrate the results obtained with the culture from the focus in this case:

Rabbit 1720, weighing 1,610 gm., was injected April 15, 1919, with 7 c.c. of a 48-hour dextrose-acacia-broth culture from the pulp of the right upper first bicuspid. April 6, the left eyelids were glued together by exudate. The vessels of the iris and of the sclera surrounding the cornea were markedly congested, but there was no turbidity of the anterior chamber. The right eye was normal. The rabbit appeared muscle-sore, generally weak, and its respirations were slightly increased. April 17, there was marked injection of the vessels of the iris and sclera surrounding the cornea in both eyes. The right eye was enucleated by Dr. Benedict. Examination showed hemorrhagic exudate in the posterior surface and peripheral margins of the iris. The rabbit appeared to be weak and muscle-sore, and tended constantly to crouch and to lie on its side as if it were painful to stand. April 18, the animal was extremely weak, and just able to walk. The fluid in the anterior chamber of the left eye was very turbid. The rabbit died at 10:30 a. m. A moderate number of hemorrhagic lesions of the muscles, especially surrounding the nerve trunks of the abdominal wall, and small hemorrhages of the tendinous portion of the muscles of the extremities and deep muscles of the shoulder and hip joints were found. The peridental membrane on the left lower incisor, especially near the apex and the pulp of the tooth were hemorrhagic and edematous, and microscopically the pulp showed leukocytic infiltration and diplococci adjacent to or in hemorrhagic areas. (Fig. 15.) In the corresponding left inferior dental nerve was a number of small punctate hemorrhages. The pulp of a number of the molars was hemorrhagic. A few small circumscribed hemorrhages were found in the cecum. The uterus contained three necrotic placental masses; the peritoneum covering these areas was hyperemic and covered with a thin layer of fibrin. The lungs, stomach, heart, kidneys, adrenals, superior dental nerves, joints, brain, and cord were free from lesions. Blood-agar plates and tall tube cultures in dextrose broth of the vitreous and turbid fluid in the anterior chamber of the extirpated eye were negative. Blood-agar-plate cultures of the turbid fluid of the anterior chamber of the left eye after death showed a moderate number of green colonies of streptococci and a few colonies of colon bacilli. Dextrose-acacia-broth cultures of this fluid contained many colonies in the fibrinous film in the middle portion of a tall tube, but no diffuse growth. A diffuse cloud in the lower two centimeters, but no growth in the rest of the tube developed in the dextrose-acacia-broth cultures from the iris of the extirpated right eye. (Text Fig. 1, Tube II.) Cultures from the iris of the left eye, after death, in dextrose-blood-broth showed a marked diffuse cloud in the lower half of the tube, and a less dense cloud in the upper one-half, due to the short-chained streptococci in pure culture. A few colonies of green-producing streptococci developed in blood-agar-plate cultures from the fresh hemorrhagic pulp of the left lower incisor, while those from corresponding normal pulp of the right upper incisor were sterile. A moderate number of green-producing streptococci and a few colon bacilli were found in cultures from the blood.

Case 3458, a woman, aged 23, came to the clinic because of pain in the left eye. Three days before, a foreign body had become lodged in the eye, causing considerable pain and lacrimation. The eye was washed with boric acid solution, and the patient felt relieved, tho the pain prevented her from sleeping during the night. The following day, while she was working, the eye gradually became more painful, Dr. Benedict found injection of the conjunctiva, a clear

cornea a normal fundus but no evidence of a foreign body. The patient subsequently developed a typical attack of keratitis and iritis. A general examination was negative. The dental examination by Dr. Gardner showed four impacted molars, and a fracture of the roots of both upper central incisors, sustained eleven years previously. The impacted and fractured teeth were extracted, and the socket of the incisors curetted. The patient made a rapid recovery. The pulp of the right upper central incisor was calcified, the pulp chamber of the left was enlarged and filled with a foul smelling pus, and this tooth had a small granuloma over its apex. Gram-positive diplococci were identified in smears from the pus, a large number of fusiform bacilli, and cocci of varying size. A blood-agar-plate of this pus produced a moderate number of indifferent colonies of staphylococci, but no green nor hemolytic streptococci. Cultures in dextrose-blood-broth of the foul pulp produced a diffuse cloud, due to short-chained streptococci. A blood-agar-plate of this culture showed green-producing streptococci in pure form. Cultures in dextrose-blood-broth of the granuloma over this tooth, of a splinter of bone from between the two teeth, and of the calcified pulp of the right incisor showed in 24 hours a diffuse cloud in the lower two-thirds of the tube, gradually rising to the top. The same type of streptococcus was isolated from blood-agar plates of the dextrose-blood-broth culture as from the foul pulp. Microscopic sections of the granuloma showed chiefly old dense fibrous tissue containing various sized, highly cellular areas. (Fig. 7). The areas of infiltration contained fibroblasts, plasma cells, endothelial cells, arranged in rows, resembling capillaries, and a moderate number of leukocytes. Gram stain of the fresh granuloma showed an occasional diplococcus, usually in or adjacent to the cellular areas or blood vessels. At the apex of the granuloma near a blood vessel was found an area (Fig. 7) which contained a considerable number of diplococci. (Fig. 8). Primary dextrose-blood-broth cultures of the foul pulp, of the calcified pulp, and of the granuloma were injected intravenously into three rabbits, respectively.

All of these had iritis, and lesions of nerve trunks, and one had lesions of the muscles. The first two rabbits had marked lesions of the pulps and contiguous structures of teeth, the third did not. The culture of streptococcus from the iris of one of the rabbits (R 1699) was injected into two others. Both developed lesions of the muscles, and lesions around the pulps of teeth and dental nerves and jaws. Only one of the five rabbits died from injections; the others were anesthetized for examination in from three to six days.

Rabbit 1699, albino, weighing 1,100 gm., was injected intravenously April 30, 9 A. M., with 3.5 c. c. of the dextrose-blood-broth culture of the foul pulp. A small amount of sterile sand was added to a few drops of this culture and placed in the right conjunctival sac. At 8 p. m. the vessels of the iris and surrounding conjunctiva were congested and both eyes were affected by lacrimation and photophobia. The rabbit seemed well otherwise. May 1, 7 A. M., the congestion of the vessels of the eyes was more marked (Fig. 2), and the animal appeared muscle-sore, inactive, with a tendency to crouch on its abdomen. The fluid in the anterior chambers was cloudy. At noon, the animal appeared weaker; congestion in the eyes had diminished. At 8 P. M., the animal jumped out of its basket in a convulsive seizure and died in violent convulsion fifteen minutes later. The circumcorneal congestion disappeared as death occurred. The examination was made immediately. The iris of each eye was

opaque and showed focal hemorrhages. The fluid in the anterior chamber was turbid. There were numerous hemorrhages of the posterior aspect of the iris and in the ciliary body. (Figure 3). The base of the appendix and the mesenteric lymph glands draining the appendix were swollen and hemorrhagic. There was marked degeneration of the myocardium, hemorrhages of the superficial muscles and aponeurosis about the thorax (Figure 23), punctate hemorrhages in the thymus, numerous subendothelial hemorrhages in the septal wall in the left ventricle and in the papillary muscles. The parathyroid glands were extremely red and appeared edematous and swollen. The thyroid was hyperemic. In the first centimeter of the duodenum were a few small punctate hemorrhages; the mucous membrane of the cardiac end of the stomach was hyperemic; the lymph glands beneath the angle of the jaw and ear, and along both superior and maxillary nerves were edematous and hemorrhagic; the axillary and inguinal lymph glands were normal; those in the popliteal spaces were hemorrhagic and edematous, and the posterior tibial nerves were swollen and hemorrhagic. The periosteum (Figure 23) opposite the right lower incisor was edematous and easily separated from the bone; the tooth was loose in the socket. The peridental membrane and the pulp were edematous and hemorrhagic. The corresponding inferior dental nerve was hemorrhagic and a number of the pulps of the molars on that side were hemorrhagic and edematous (Figure 23). The pulp of the left lower incisor and the left inferior dental nerve were normal. The superior dental nerves were edematous and contained a few punctate hemorrhages. Smears from the hemorrhagic area in the periosteum and from three dental pulps showed a Gram-positive diplococcus, but no other bacteria. Blood-agar plate cultures of the blood, of the fluid from the anterior chamber, and of the pulp of the right lower incisor were negative. Dextrose-blood-broth cultures of the tissue of the iris and the pulp of the right lower incisor showed diffuse growth of a short-chained streptococcus, beginning in the bottom of the tube and gradually forcing its way to the top. Sections of the eyes showed marked hemorrhage and leukocytic infiltration of the ciliary body and iris. (Figure 19). Gram strains showed scattered diplococci in and adjacent to areas of hemorrhage. (Figure 20-B).

Rabbit 1700, a female weighing 1,720 gm., was injected intravenously April 30 with 5 c.c. of the dextrose-blood-broth culture from the calcified pulp of the right upper central incisor. A few drops of culture were mixed with sterile sand and dropped into the right conjunctival sac. May 1, the animal appeared fairly well, but there was lacrimation and moderate congestion of the vessels of both eyes. May 2, the eyes appeared normal, and the rabbit appeared well generally. The animal did not use the right hind leg, which it held up as if it were painful. Slight pressure along the sciatic nerve and posterior aspect of legs seemed to cause pain. The joints were not swollen. May 3, conditions were about the same, and chloroform was administered slowly; the animal went to sleep without a struggle. Marked infiltration and edema of the subcutaneous tissue of the posterior and lateral aspect of the lower two-thirds of the right leg and plantar surface of the foot were found. There was hemorrhage and infiltration along the sheaths of the nerve trunks and sheaths of the plantar surface of the right foot. This infiltration was most marked immediately surrounding the lower one-third of the posterior tibial and accompanying nerve in the right leg. The tissues surrounding these nerves were extremely edematous and swollen,

including the tendon Achilles and its bursa on the posterior aspect of the os calcis. (Fig. 22). The plantar infiltration and suppuration followed the nerve trunk and extended into the tissues and sheaths of the tendons. The ankle and phalangeal joints were normal. The left posterior tibial nerve showed a few hemorrhages in the upper one-third, and the bursa of the attachment of the tendon Achilles was only slightly swollen. A number of small hemorrhages was associated with whitish streaks and localized edema in the more tendinous portion of the muscles of the anterior aspect of the left tiba with a large area surrounding a small nerve in the deeper layer of the muscles. There was an area of hemorrhage and infiltration in the intercostal muscles beneath the shoulder blade of the right thorax. (Fig. 26), and a large hemorrhage associated with edema in the periosteum of the upper left jaw opposite the apex of the upper left incisor. (Fig. 25). The left superior dental nerve was hemorrhagic and edematous, with a number of whitish areas of infiltration. The pulp of the left upper incisor was hyperemic and edematous. The pulps of the molars on the left side were edematous; those on the right side appeared normal. The right superior dental pulp and nerve were normal. There were no lesions of the nerve trunks other than those mentioned. The uterus was much enlarged and contained five almost full term fetuses. In the first fetus were a few whitish lesions of the muscles of the abdominal wall along the blood vessels and nerve trunks, a few hemorrhages in the muscles about the neck and between the toes of the subcutaneous tissues of the plantar surface of the left foot, hemorrhage and edema in the posterior aspect of the left leg, and around the ankle joint of the right leg was a group of hemorrhages. In the second fetus was a group of hemorrhages between the third and fourth toes and the upper aspect of the little toe and a group of hemorrhages in the muscles of the anterior aspect of the left ear. In the third fetus was a number of hemorrhages of the muscles of the inner and upper aspect of the left tibia. In the fourth fetus the only lesions were small punctate hemorrhages of the intercostal muscles and muscles of the back. (Fig. 27). In the fifth fetus were small hemorrhages in the skin over the left shoulder blade. Cultures from the heart blood and ammiotic fluid of the adult rabbit were negative. Cultures from the pus around the right posterior tibial nerve of the adult rabbit showed countless numbers of colonies of green-producing streptococci. In the smears were moderate numbers of diplococci. No growths were produced from cultures of the fluid in the eyes and brain substance of two of the fetuses, while dextrose-blood-broth inoculated with the hemorrhagic muscles of the left leg of the third fetus showed in 24 hours diffuse growth of short-chained streptococci in the lower portion of the tube, that rose to the top in 72 hours. In the blood-agar plate of this culture was the type of green-producing streptococcus injected into the adult rabbit in pure form.

Summary and Discussion.

Experimental Findings: By the use of the method described it is possible to obtain fairly accurate information of the number and kind of microorganisms in various dental infections, as well as their location in relation to the blood supply. The cultures from apical abscesses and pulps of teeth, in my hands as in the studies of Henrici and Hartzell, (18) Moody, (29) and others, showed the green-producing streptococcus, often in predominating numbers, as an almost constant organism in these areas. A detailed study of some of the strains isolated is reserved for a more extensive study of streptococci from various

sources. Streptococci were often isolated in pure culture, in some instances even tho smears from the foul-smelling pus also showed staphylococci and fusiform bacilli. All the cultures of streptococci manifesting a preference for anaerobic conditions in the primary culture as illustrated in Text Figure 1 ultimately became aerobic when, with few exceptions, they resembled Streptococcus viridans. In no instance did they remain strictly anaerobic. Slightly hemolyzing and indifferent streptococci and indifferent staphylococci occurred next in frequency. The fusiform bacillus was found almost constantly in pulp chambers or abscesses containing foul-smelling pus, but never in pure culture. Colon bacilli were commonly found together with streptococci, staphylococci, fusiform bacilli, and spirochetes in pyorrhea pockets, but they were only rarely isolated from apical infections.

The percentages indicating the localizations in the experiments summarized in Tables 1 and 2 do not adequately represent the results obtained. In the former, injections were frequently made after plating the organisms, and, in both, lesions in organs other than those affected in the patient harboring the focus were usually less marked or trivial. The experiments in animals, recorded in detail, revealed the striking tendency of the bacteria to localize in the tissues involved in each of the following diseases: transverse myolitis, multiple neuritis, chronic arthritis, and myositis, gluteus myositis, lumbar neuritis, herpes zoster, trigeminal neuralgia, mild myositis, keratitis, and iritis.

The results following injection of bacteria contained in small amounts of the pus from the tonsils show that the bacteria grown in the focus may have elective localizing power and that small numbers of those are sufficient to cause lesions in animals corresponding to those in the patient. The experiments with emulsions of tonsils show that the degree of toxicity was proportional to the amount of infection in these organs (35). On the basis of these experiments, the harm from foci of infection must be considered as being due to the absorption of toxic bacterial products as well as to the entrance of the living bacteria into the circulation and their localization. The number of bacteria in acute lesions is sometimes so small as to be difficult to find and as to suggest that the specific lesions are due in part to the formation of toxic products. This possibility is also suggested by the observation that specific localizations occur with smaller doses of the broth culture directly injected than with the centrifuged bacteria resuspended in salt solution. The focus moreover may supply alien proteins, toxic or otherwise, (37) to which an individual as a whole or the involved tissues such as joint structures may have become highly sensitive. Clinical and experimental evidence (26) of the possible occurrence of harm by this mechanism is not lacking.

The localizations following injection of the cultures from the case of mild myositis (R3368) and from the case of acute iritis (R3458) are in accord with the results obtained by Irons, Brown and Madler (24) in their study on experimental iridocyclitis in rabbits and with the results I have reported previously. These results show that experimental iritis and myositis or arthritis are prone to occur simultaneously (38). This was found to be the case following injection of strains isolated from rheumatic myositis and allied conditions, as well as of laboratory strains of streptococci when they had attained a certain grade of virulency from animal passage (38). Moreover, the results in animals are in harmony with those in persons who have had repeated attacks of iritis and who are prone to have myositis and similar conditions. The occurrence of lesions in the fetuses similar to those that occurred in the mother rabbit

(R1700) is especially interesting. The amniotic fluid was sterile. No bacteria were found in normal tissues in the fetuses, while the tissues with lesions contained the streptococcus injected, and hence may be regarded as the results of embolic infection. This is a special indication of elective localization since the bacteria must have passed thru the walls of four sets of capillaries before they could lodge in the specific tissue. Specific localizations in the fetuses have been noted also in experiments in influenza. In this connection it should be mentioned that Curtis (6) found that streptococci, associated with spontaneous abortion in women, when injected intravenously into pregnant rabbits, tend to lodge in the uterus and to produce abortion or absorption of fetuses. The view held by many obstetricians, (48) that foci of infection predispose to eclampsia, abortions, and to ill health of the fetus would thus seem to have experimental basis.

The inability to obtain the specific localization at any one time in animals injected with bacteria from these foci should not necessarily be considered as evidence that a causal relationship might not have been present at some other time, for I have shown repeatedly that peculiar infecting powers may be lost in a focus just as in artificial media and from animal passage, a finding which Irons, Brown, and Nadler (24) corroborate. The occurrence of lesions other than the specific ones in organs or tissues of animals injected with relatively large doses should not detract materially from the general truth of the elective localization theory, and should be looked on as evidence for, rather than against, causal relationship between focus and systemic disease. The non-specific lesions are usually relatively slight, roughly in proportion to the size of the dose, and may not occur if the dose is accurately gauged. They tend to occur in the same type of tissues in a series of animals. The tissues involved commonly correspond to those frequently affected in persons with certain diseases which are not demonstrably present at a given time, but which may become manifest later. In a previous paper it has been shown that cultures from chronic foci of infection at the time of acute attacks of systemic disease, such as appendicitis, tend to reproduce the acute disease in animals, but that this may not be the case subsequently. This finding has been interpreted by some observers (22) to mean that the organism in appendicitis enters the appendix from its lumen, passes into the blood stream, and on to the focus. This is conceivably possible in acute appendicitis but in other diseases, which must be regarded as of embolic origin, this interpretation would seem illogical. Experimental appendicitis follows intravenous injection of the proper strains, a fact which has been noted also by Helmholz and Beeler, (20) but it has never been produced by placing the bacteria into the uninjured lumen of the appendix of animals. An acute exacerbation in the focus should occur if the bacteria from acute infections suddenly become lodged in the chronic focus, but such exacerbations do not occur. It is a well-established clinical observation that systemic invasion commonly occurs not at the time of an acute attack of tonsilitis or of acute pulpitis, but some time after the acute symptoms have subsided, usually in from ten days to a month. It is during this time, as I have pointed out, that bacteria may acquire specific infecting power. The changes in the focus take place gradually and hence are not accompanied by evidence of acute exacerbation. Accordingly, the interpretion that the systemic disease is the result of embolic infection, whether aided or not by local predisposing factors, from a distant focus would seem more true to fact.

Howe (22) questions the significance

of my experiments on the production of ulcer by intravenous injection of streptococci. He states: "Bertram says that for half a century it has been recognized that a peptic ulcer forms when a circumscribed area of the stomach loses its normal resistance thru malnutrition or neurosis to the digestive effect of the gastric juice, and is digested. Burge and Burge assert that decreased resistance of a circumscribed area of the stomach to gastric juice due to a decreased oxidative process of the cells of the area, followed by subsequent digestion of the area by pepsin, is the explanation of gastric ulcer." These observations still leave the cause of the local disturbance undetermined. The results of my experiments indicate that the local malnutrition or neurosis described by Bertram and the circumscribed area of decreased oxidation described by Burge and Burge commonly are due to embolic localization of streptococci having affinity for the mucous membrane of the stomach.

The tendency to systemic invasion in acute infections about the teeth and jaw is recognized by all. Some observers have suggested that the rôle played in the causation of systemic ills by chronic localized infections about the teeth and jaws, particularly infected pulps, apical abscesses, and granulomas, must be unimportant because nature's efforts are quite sufficient to protect the individual who harbors them; that the wall of connective tissue in a granuloma makes invasion of the blood stream by bacteria impossible or highly improbable, and that since these conditions are so often free from symptoms they must be harmless. In the light of the results of the experiments reported herewith, this explanation does not seem tenable. It is a well-known fact that new blood vessels are formed constantly during inflammatory reactions following injury of tissue from any cause. It has been shown that the bacteria in granulomas and pulps of teeth occur chiefly where the connective tissue is highly cellular or embryonic in character, where leukocytic and round cell infiltration is present, where new blood vessels are being formed, and adjacent to the or within the larger blood vessels. (Figs. 5 to 13). It is evident, therefore, that the bacteria do not need to pass thru a dense wall of connective tissue to enter the lymph or blood streams even in the most chronic conditions. The close proximity of the bacteria to the blood vessels and to active lesions has been noted in recently infected pulps; in granulomas which had existed for from five to twelve years, and in infected pulps of animals injected intravenously a short time previously. The sclerotic connective tissue should be regarded as the result of a long-continued infective process which tends to protect the surrounding structures from bacterial invasion, but which has little power to prevent invasion of the blood or lymph streams. Indeed, by virtue of the density of the connective tissue, which allows no expansion, it might be regarded as tending to force the bacteria and their products during exacerbations of these infections along the line of least resistance into the circulation. It is not improbable that the plunger effect from mastication tends to drive the bacteria and their toxic products in apical infections in the same direction. Since pain in these areas is the result chiefly of pressure, the absence of this symptom should be regarded as evidence that free drainage into the circulation of the bacteria and their products is afforded, rather than as evidence of the harmlessness of these conditions. In the light of these findings, moreover, freedom from demonstrable systemic disease, often for long periods, in persons who harbor these infections may be considered to be due more to general resistance, to a natural or acquired immunity, than to a local protection from encapsulation of the microorganisms.

In order that an infection from septic

foci may become established in remote body tissues, the same laws of resistance which afford protection against microbic invasion from other sources must be overcome. A focus of infection wherever found—it may be in the intestinal tract, which, for mechanical reasons, can neither heal nor drain—that is teeming with micro-organisms, should be regarded as a test tube with permeable walls imbedded in the tissues where absorption channels for bacteria and their products are present. In consequence the play between the living bacteria and their products, and the protective mechanism of the host, becomes forced. A certain degree of immunity no doubt results, but since the bacteria (streptococci) usually present are poor antigens, the immunity induced is transient, and since a state of increased susceptibility or hypersensitiveness from overstimulation may supervene, the protection may be inadequate. This is what occurs commonly during the immunization of horses and other animals with living streptococci, if the dose is not accurately gauged.

There is another reason why the mechanism of immunity may be inadequate to afford protection. By virtue of the gradation of oxygen pressure and the presence of mixtures of bacteria in primary foci, the bacteria may change in immunologic characteristics and in infecting powers. In that case the antibodies previously formed would be valueless. Before antibodies which would react with the new strains could be formed, opportunity for invasion and the production of localized lesions by the changed organisms could occur.

It has been stated by some workers that the bacteria, especially streptococci from chronic localized dental infections, are a virulent, and therefore not to be considered of etiologic importance. If virulence is understood to mean the power of aerobic cultures of these organisms to kill animals by overwhelming infection following their injection, disregarding the fact that most of the diseases apparently due to focal infection remain localized and are not overwhelming infections, then this contention is correct, but if virulence is taken to mean the power to produce lesions, as determined by careful necropsies in anesthetized animals, it does not hold. By the use of cultures grown under partial oxygen tension, we have found that the bacteria in many of these foci are pathogenic, in some instances markedly so, and that they tend to lodge and produce lesions in the tissues or organs of animals, corresponding to those involved in the patient from whom the culture is taken. This finding is in accord with the rather common occurrence of acute exacerbations in these infections following various manipulations thru the root-canals in attempts at sterilization. The results with partial oxygen tension cultures lend some support to the view held by many that this phenomenon is associated in some way with the entrance of air or oxygen.

The importance of affording the bacteria in these experiments a gradient of oxygen pressure and of injecting the bacteria soon after isolation cannot be too strongly emphasized. The first consideration, in this study, has been to determine whether the foci contain living bacteria which can reproduce the disease in animals. If aerobic cultures only are made, no growth may occur in inclosed foci in which partial or complete anaerobes are present or only nonpathogenic organisms may develop, as in open infections such as pyorrhea, in which a mixture is constantly present. Thus negative results in animals injected with a pure culture, such as green-producing streptococci grown aerobically, have little value since it is quite likely that the parasitic strain failed to grow or that the property on which localization depends has been destroyed. By the use of methods embodying these principles, specific and other lesions have been produced with bacteria

from the various types of dental focal infections, such as gingivitis, pyorrhea, infected pulps, apical abscesses, discharging sinuses, and granulomas. The tendency to produce lesions in the pulps of teeth in animals was more marked when bacteria from infected pulps were used than when they were taken from other dental foci or foci elsewhere. This was especially true if the pulp showed evidence of recent infection. In some instances, however, lesions resulted from the use of strains isolated from tonsils or other foci outside the dental field. In one case of recurring attacks of pyorrhea injection of animals with cultures from the pus pockets, during an acute attack, caused hemorrhage and edema of peridental membranes. Parallel series of animals were injected with cultures from infected tonsils and various dental foci in many of the cases, and in some with cultures from the metastatic lesions as well. Usually the localizations were strikingly similar. The injection of the primary cultures of pus from tonsils and open infections about the teeth, such as pyorrhea tended toward a wider range of localization than that which followed injection of cultures from enclosed infections about the teeth and about the metastatic lesions. Lesions in the tonsils of animals were found in only a few instances and only when lymphoid tissue in other parts of the body was hemorrhagic. This finding is to be expected since the tonsils studied showed little evidence of inflammation, and since the infection in the pockets in these organs is really outside the tonsil proper. The injection of a single small dose was sufficient at times to produce the specific localization, but a fair sized dose should be injected before the result is considered negative. In order to simulate the condition in the patient more closely, in that the bacteria would need to pass thru a series of capillaries before reaching the specific tissue, in some of the diseases studied, intraperitoneal injections were made with cultures. Even this method was followed by elective localization, in some instances. In the experiments with pus from tonsils, a small number of the bacteria which had grown in the focus was sufficient for elective localization. In parallel experiments, which will be reported shortly in a study on myositis, cultures of the pus from tonsils from normal persons and from persons suffering from metastatic disease show that the former may be harmless, and that the latter are prone to produce lesions in the tissues corresponding to those involved in the patient.

The identity of streptococci isolated from specific experimental lesions following injection of cultures from foci of infection and the metastatic lesion, has been established in some instances. Improvement occurred in patients from whom foci were removed, which were proved to contain the specific organism at the time of removal. The organisms have been demonstrated in the lesions in animals altho absent elsewhere by cultures and in sections (20, 33, 34, 35, 42, 45). Reinjection in animals produces characteristic lesions, and the organisms may again be isolated. Experiments with filtrates of the cultures have proved the absence of a filtrable virus. The requirements for the demonstration of etiologic relationship between extraneous parasites to disease have been fulfilled.

The results reported heretofore on elective localization of bacteria from foci of infection have been verified and extended. The findings warrant the conclusion that chronic foci of infection about the teeth are potentially or actually detrimental to the health of the persons who harbor them. The lesions which are more or less enclosed, and which drain only into the circulation, are probably the most dangerous and should be regarded as veritable experiments which alone or in connection with predisposing factors will sooner or later

break down the resistance of the patient and produce disease. The harm from oral sepsis, according to the experiments with emulsions from the infected tonsils and with the bacteria in the pus from tonsils, may be due to absorption of poisonous bacterial products and to the living bacteria themselves. The place of localization of the bacteria, aside from the influence of a lowered resistance, local or general, from injury, fatigue, strain, improper food, bad hygiene, disease, heredity, etc., will depend largely on the peculiar infective, or the peculiar poison-producing power of the bacteria at hand.

Clinical Findings: Let us consider the frequency of probably the most dangerous form of dental sepsis, pulpless teeth and blind abscesses. Howe (22) reports the presence of 40,000 abscessed teeth in an examination of 50,000 children at the Forsythe Dental Infirmary, and points out that abscessed teeth must be of little importance as a source of infection since arthritis deformans (a disease which rarely occurs in childhood) was not observed. It is to be regretted that no information is given with regard to the condition of these children at the time of the examination, for example, the number who later suffered from malnutrition, hypertrophied and infected tonsils, and adenoids leading to malformation of the jaw, defective teeth, and to deficient mental and physical development, and the number who had appendicitis, endocarditis and so-called "idiopathic" infections, fatal or otherwise, in which the teeth were not even suspected as being a possible source of these infections. Langstroth, (25) in his studies of cases at the University of California Hospital found chronic focal infections in 84 per cent of ulcer patients, in 66 per cent of subacute cases of arthritis, in 73 per cent of the chronic cases of arthritis, and in 100 per cent of the gall bladder cases. The acute and subacute cases responded well after removal of the foci even to the point of absolute care. In many of the chronic cases, the patients had less pain and no further progression of the disease. Duke, (10) in tabulating 1000 medical cases in which the patients suffered from some form of chronic disease, found a marked degree of oral sepsis in 66 per cent. Thoma (49) in a similar group of cases at the Robert B. Brigham Hospital in Boston found alveolar abscess in 88 per cent. Irons (23) found alveolar abscess in 44 per cent in a series of 124 patients with miscellaneous diseases. Abscesses were present in 76 per cent of the arthritis group and in 47 per cent of the nephritis group. Black (4) found that the peridental infections, without reference to complaint, were 56 per cent in persons under 25 years of age, 72 per cent in persons between 25 and 30, 87 per cent in persons between 30 and 40, 89 per cent in persons between 40 and 50, and 100 per cent in persons more than 50. Many of these infections are found in teeth from which the pulp has been removed artificially, and the canals improperly filled, as is shown by Ulrich (51) who found that 68 per cent of all artificially devitalized teeth showed apical abscesses, and that of 1350 so-called dead teeth examined 83 per cent were abscessed. The number of persons suffering from diseases directly attributable to these infections as well as from non-related conditions which have been cured or benefited by elimination of foci of infection in the various branches of medicine is so large as to be quite sufficient to prove the general truth of the idea of causal relationship.

Therapeutic Suggestions.

The opportunity of the dental profession for cooperation with the various branches of medicine along these lines needs no emphasis. The prevention of oral sepsis in the future with a view to lessening the incidence of systemic disease should henceforth take precedence, in dental practice, over the preservation

of the teeth almost wholly for mechanical or cosmetic purposes as has been so largely the case in the past. Every effort should be made for the prevention of dental infections and for the correction of those already present. Preventive measures should begin in childhood with a view to obtain perfect development of the teeth and oral cavity and thus prevent various defects which would later lead to sepsis. This calls for the cooperation of dentist, pediatrist, and throat specialist.

The principles underlying various procedures for the prevention and cure of infections of the gums and enveloping membranes about the roots of teeth may be regarded as fairly well understood and effectively applied by many. It should be emphasized, however, that the chief harm from these conditions comes from the absorption of the bacteria and their products into the lymph stream or blood, especially if drainage is inadequate, not from swallowing the infectious material, and that the infections predispose to embolic infections within and without the dental field. The correction of pyorrhea and allied conditions is, therefore, of great importance.

Infections of the dental pulp, pulpless teeth, and apical abscesses are theoretically the most dangerous of the various forms of dental foci. They are usually free from symptoms and hence unsuspected. They are situated in osseous tissue which allows no expansion. They lack drainage other than into the circulation and are exposed to pressure transmitted by the teeth during mastication. They remain active and do not heal for a period of years, and the bacteria, as shown in this study, are not encapsulated as is usually assumed, but are found in areas of active inflammatory reaction where new blood vessels form and afford ample drainage into the circulation.

On the basis of these facts, there can be no doubt that the wholesale devitilization of teeth, often for trival reasons, and the filling of infected root-canals without due regard to asepsis, as practiced in the past, results in the formation of numerous apical infections, and, no doubt, in much ill health. The instances of cure or improvement in systemic diseases directly attributable to these infections and in non-related conditions are so numerous that the procedure as practiced heretofore should be regarded as a veritable experiment.

It is a well-known fact in bone surgery that no amount of antiseptic treatment will cure an osteomyelitis unless dead tissue is removed and dead spaces are eliminated; if this is done healing occurs promptly without antiseptic treatment. In the filling of root-canals the removal of every particle of pulp tissue is recognized as a prerequisite for successfully preventing subsequent infection. Is there any reason to believe that if the small amount of dead albuminous matter in divergent or tortuous canals leads to reinfection (46) that the larger amount in the apical region would not likewise become infected even tho completely sterilized by ionization or other similar treatment? Hence it is doubtful whether any form of medication thru the root-canal, which would be applicable in routine practice, can be relied on successfully to sterilize the infected areas about abscessed teeth, and to prevent the areas from becoming reinfected. The fact that acute infections of the jaw occur not infrequently following these attempts is a further obstacle to the success of this method. Apicoectomy, while no doubt successful in removing the infection in the jaw in some instances, is applicable in only a small number of case, and as a rule should not be attempted in persons who are ill from secondary systemic conditions. The removal of infected pulpless teeth together with the infected peridental tissues therefore seems to be the safest and surest means available at present for the cure of these conditions.

The many ingenious devices applicable to vital teeth will do much in making useful masticating surfaces and agreeable cosmetic effects.

It is becoming more and more apparent that the lack of improvement in systemic disease following the extraction of one or more infected teeth, barring other foci, may be due to the fact that the peridental infection was left or was only partially removed, and that the occurrence of acute exacerbations following extraction and curettement is commonly due to this cause. Persons who have had all their teeth extracted may still harbor localized areas of infection in the jaws. Simple extraction is not sufficient. The importance of eliminating dead spaces in curing infections of bone in other parts of the body—a lesson learned during the war—lends support to the idea of the "surgical removal" of infected teeth. Removal would seem to be the method of choice in cases of extensive apical infections. If a person is perfectly well, has harbored for some years one or more devitalized teeth in which the x-ray findings are negative, there would seem to be no good reason for extraction. If on the other hand, the person is suffering from arthritis, a heart or kidney affection, or some other form of disease for which other causes cannot be found, such teeth should be removed. Owing to the reparative power of the cementum, it would seem possible to devitalize teeth safely whose pulps are sterile and whose canals may be properly filled, provided the operation is done in an aseptic manner. This should be done after the removal of other sources of infection, and only in teeth of vital importance for restorative needs. The somewhat lowered resistance to infection of the peridental tissues about non-vital sterile teeth may be more than counterbalanced by the removal of the pulp, since most infections of otherwise sound teeth no doubt occur thru this organ. In case of beginning infection of the pulp from decay which has not yet extended into the periapical tissues, attempts at sterilization, and, if necessary, removal of the pulp and filling the canal may be justified in some instances, but not until cultures have proved that the tissues are free from living bacteria, and only if the responsibility is shared conjointly by patient and operator.

In the matter of eliminating foci of infection in the mouth and throat, the infections about teeth should as a rule be corrected first (44). Tonsillectomy as now so commonly practiced before the condition of the teeth has been corrected is illogical. The lymphatics of the mouth and jaws drain into the tonsils. Some infections of tonsils improve or even disappear following the extraction of infected teeth. The unnecessary sacrifice of vital teeth should be condemned. Barker (1) states: "I do not think a tooth should be sacrificed unless indications are clear for its removal. I would urge you not to give widespread orders to extract teeth unless they are so diseased that they must come out. On the other hand, please do not try to save teeth than cannot be made aseptic, for there is real danger that they may injure the rest of the body." A patient who is suffering from a serious disease of focal origin, after due consideration of other factors for or against extraction of infected teeth, should be given the benefit of the doubt even when the evidence is not conclusive that the responsible focus is contained therein. Extraction will do no harm altho inconvenient at the time, while non-extraction may result seriously. "Not too much should be expected from the removal of a focus, especially in chronic conditions, because a similar condition may be present in inaccessible foci and in others too small to be detected. Moreover, recovery may be made difficult by local tissue sensitivity or peculiar mechanical conditions, and living bacteria in a meta-

static lesion may continue the process independently of the focal source (42)."

The administration in guarded dosage of a properly prepared vaccine from a focus following its removal may be an important aid in overcoming the metastatic condition. But this or other forms of specific therapy cannot take the place of the eradication of the focus. It need hardly be pointed out that the prevention and cure of dental and other foci of infection is only a part of the problem. The conception of the problem of focal infection must not be too mechanical, for, as has been emphasized previously, (44) and again demonstrated experimentally in this study, the invasive power of the bacteria is extremely important.

Thus in the case of pulpitis, dental neuritis, and myositis (41) in which elective localization of the streptococci from the pulp of the tooth and from the muscle was demonstrated (Figures 36 to 46), the streptococcus having the same invasive power was found aiso in the nose, pharynx, and stool.

The elimination of visible foci would not eliminate all systemic infections, for as the invasive power of the bacteria increases, the need for forced entrance, as occurs from a focus, becomes less marked and thus the bacteria may gain entrance thru the unabraded mucous membranes, as in the acute infectious diseases. But even here, the broken continuity from localized infections predisposes to these diseases (43, 46). The importance of hygiene, of a properly balanced diet, and of the general health, and hence the cooperation between the various branches of medicine and surgery, including dentistry, need hardly be emphasized.

A careful study of the clinical and experimental data now available seems to show conclusively that a sane and comprehensive effort toward the prevention and cure of septic foci in the dental and other areas will result in the alleviation of human suffering, in a better preservation of the tissues in old age, in a longer average duration of life, in increased mental and physical efficiency, in the prevention and cure of acute and chronic disease, and, thru the laws of heredity, make for a sturdier race.

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PLATE I.

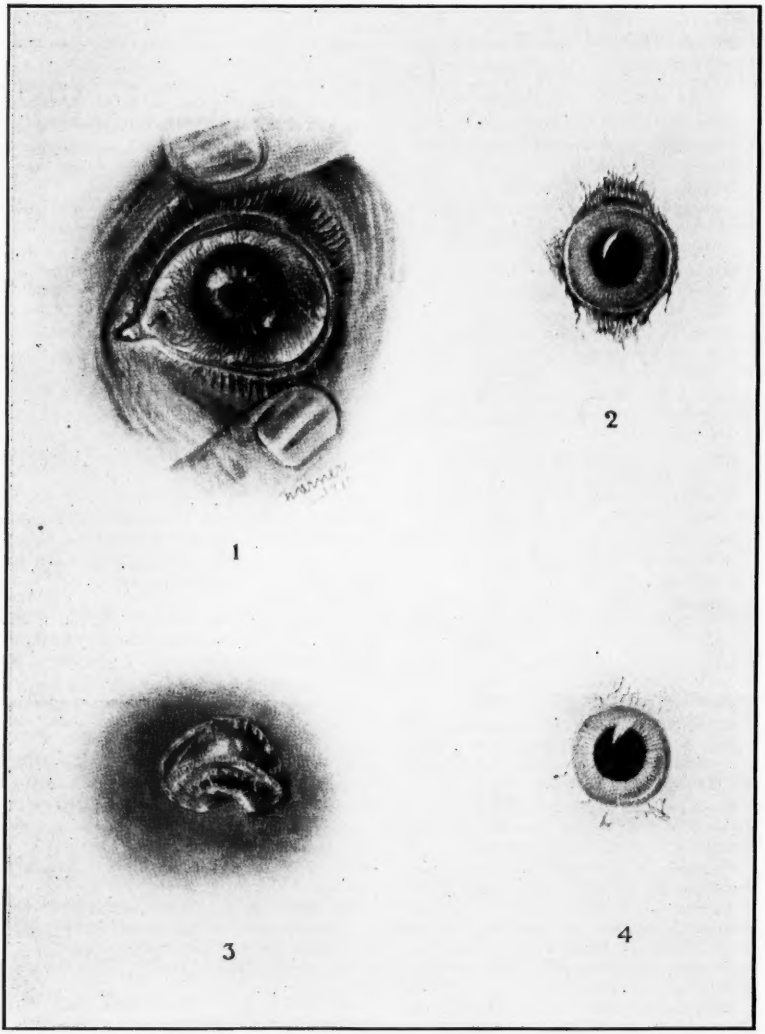


Figure 1. Drawing illustrating the condition of the eye in a case of keratitis and iritis with dental sepsis (Case 3458).

Figure 2. Iritis in Rabbit 1699 following injection of the culture from the foul pulp in a case of keratitis and iritis (Case 3458).

Figure 3. Reverse side of the iris of same Rabbit.

Figure 4. Normal iris of an albino Rabbit.

PLATE II.

Figure 5.

Photomicrograph of small granuloma near the apex of an extracted tooth whose root-canal was improperly filled five years previously. Gram-Weigert X50. This specimen was obtained in a sterile manner, incubated at 35° C for ten hours in the bottom of a tall tube of dextrose broth and then placed in 10 per cent formalin. The broth showed slight turbidity at the bottom, due to streptococci. Note the dark area at a, near the apex of the granuloma and the line at b indicating the path of the blood vessels from this area.

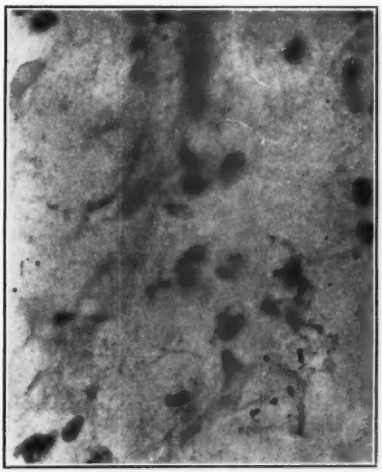
Figure 6.

Photomicrograph showing mass of streptococci in the dark area shown at a in Figure 5. Gram-Weigert X500. Painstaking search in serial sections showed this mass to be the only one thruout the tissue and hence may be taken to indicate the point where the infection existed before the tooth was extracted.

Figure 7.

Granuloma at the apex of the left upper incisor of Case 3458. Note the irregular large and small areas of cellular infiltration, and the embryonic and sclerotic connective tissue. Hematoxylin and eosin X50.

Figure 8.



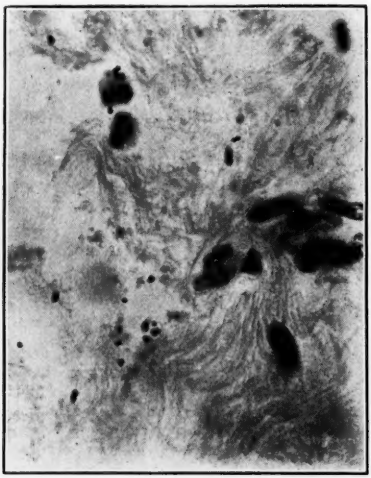
Granuloma shown in Figure 7, Gram-positive diplococci at a. Gram-Weigert XI000.

PLATE III.

Figure 9.

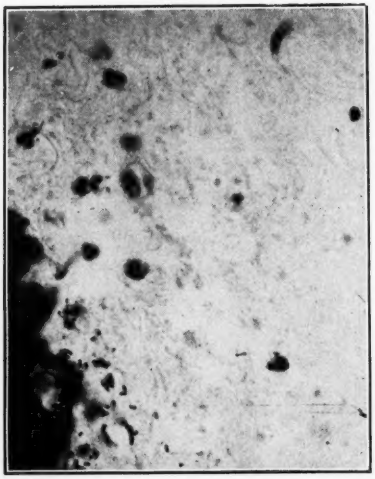
Granuloma shown in Figure 7 after incubation in dextrose-acacia-broth for ten hours. Note the dark area at a, consisting of a capillary filled with diplococci. The capillaries are lined with a single layer of endothelium at b and c. Hematoxylin and eosin X200.

Figure 11.



Granuloma shown in Figure 9. Note the capillary adjacent to the hemorrhagic and edematous area, containing leukocytes and diplococci. Gram-Weigert XI000.

Figure 10.



Granuloma shown in Figure 9. Note the large dark area at the left, consisting of Gram-positive diplococci, and the scattered leukocytes containing diplococci. This area corresponds to the one showing newly formed capillaries at b, Figure 9. Gram-Weigert X500.

Figure 12.

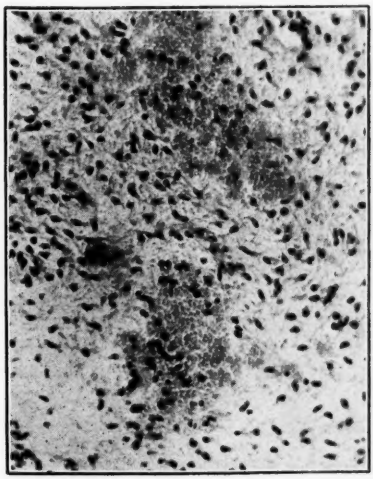
Section of the pulp of the first right upper bicuspid of Case 3368. Note the area of round cell infiltration and the dark masses filling the blood vessels. Hematoxylin and eosin X120.

PLATE IV.

Figure 13.

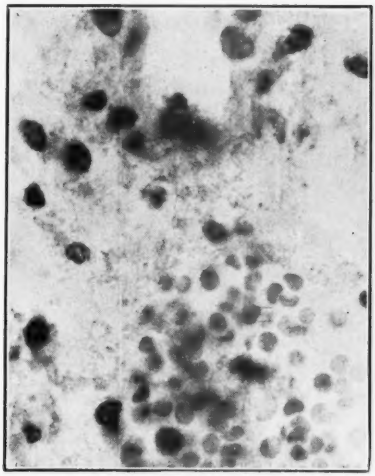
Higher magnification of the large blood vessel shown in Figure 12. Note the large number of diplococci in the blood vessel showing branching in the adjacent infiltrated tissue. Gram-Weigert X500.

Figure 14.



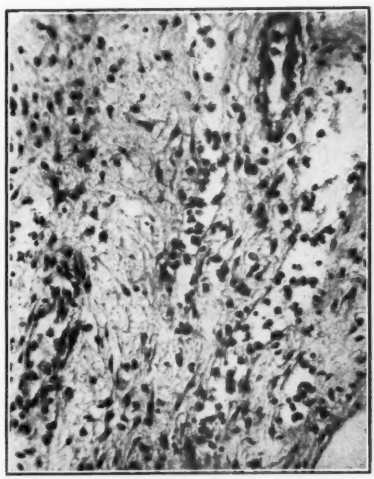
Section of the pulp of the left lower incisor of Rabbit 1720 injected with the culture from the pulp of the tooth in Case 3368. Note the areas of hemorrhage and leukocytic infiltration. Hematoxylin and eosin X200.

Figure 15.



Section of the dental pulp shown in Figure 14 showing diplococci, leukocytes, and hemorrhage adjacent to the capillary. Gram-Weigert X1000.

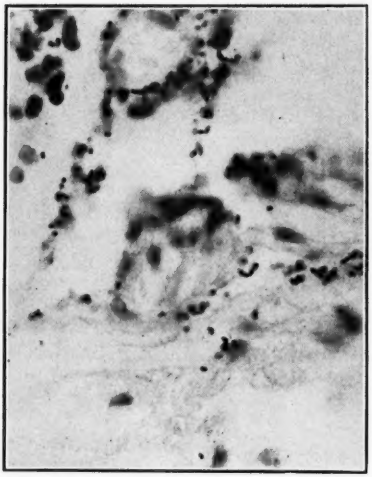
Figure 16.



Section of the dental pulp shown in Figure 14 after incubation for ten hours in dextrose-acacia-broth. Note the large number of leukocytes in and adjacent to the capillaries. Hematoxylin and eosin X200.

PLATE V.

Figure 17.



Dental pulp shown in Figure 16. Note the large number of streptococci in and adjacent to the capillary walls, and in and along the lymph channels. Gram-Weigert X1000.

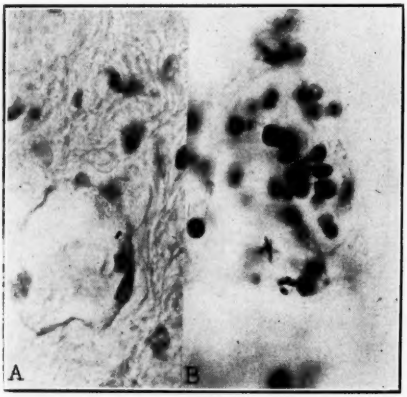
Figure 18.

Section of the ciliary body and iris of Rabbit 1720 injected with the culture from the dental pulp of Case 3368, showing marked hemorrhage and infiltration. Methylene blue and eosin X50.

Figure 19.

Section of the uvea of the eye of Rabbit 1699, shown in Figure 2, injected with culture from the tooth in the case of keratitis and iritis. Note marked hemorrhagic and leukocytic infiltration. Hematoxylin and eosin X100.

Figure 20.



A. Diplococcus in capillary of hemorrhagic ciliary body shown in Figure 18. B. Diplococci in the hemorrhagic area shown in Figure 19. Gram-Weigert X1000.

PLATE VI.

Figure 21.

Nerve trunks of the lumbar plexus and sciatic nerve in Rabbit 845 injected with a culture from the tooth in the case of lumbar neuritis (Case 628). Note the hemorrhagic areas in the former and the absence of lesions in the latter. X2.

Figure 22.

Posterior tibial and accompanying nerves and facia of Rabbit 1700, injected with cultures from the calcified pulp in Case 3458. Note the extreme swelling and hemorrhage of the nerve and surrounding structures of the right leg, including the bursa at the attachment of the tendon achilles as compared with same structures in the opposite side. XI.

Figure 23.

Photograph of hemorrhagic dental pulps, left inferior dental nerve, posterior tibial nerves, and superficial muscles and aponeurosis of Rabbit 1699 injected intravenously with culture from the foul pulp of the left upper central incisor in Case 3458.

Figure 24.

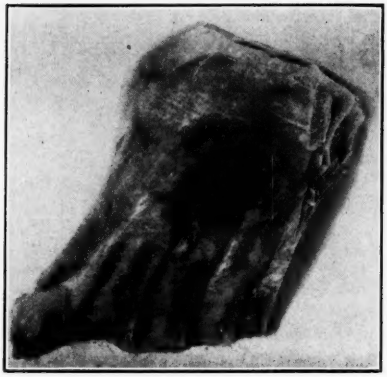
Hemorrhagic appendix of rabbit injected intravenously with the dextrose-brain-broth culture of streptococcus isolated from the tissues about the apex of the second left lower bicuspid devitalized twenty years previously. X½.

PLATE VII.

Figure 25.

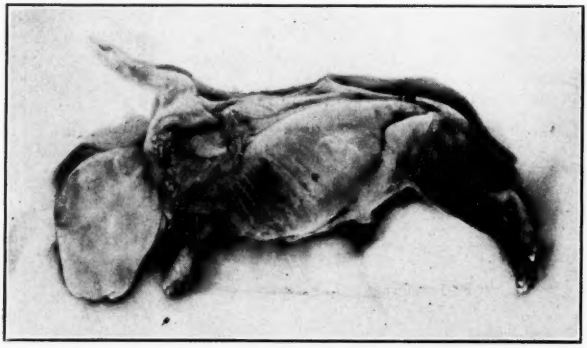
Hemorrhagic and edematous area in the upper jaw of Rabbit 1700.

Figure 26.



Hemorrhagic area of intercostal muscles of Rabbit 1700.

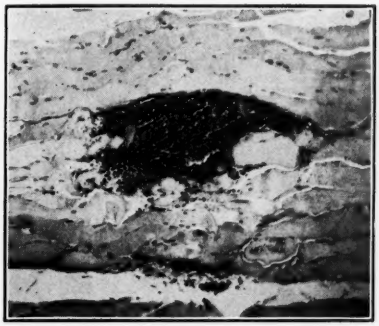
Figure 27.



Hemorrhagic area of intercostal muscles of Fetus 4, Rabbit 1700.

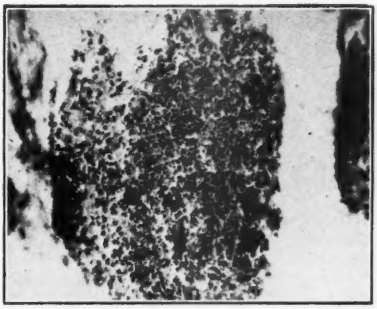
PLATE VIII.

Figure 28.



Lesion in the gluteus maximus of Rabbit 818 injected with the culture from granuloma in the case of recurring attacks of gluteus myositis (Case 623). Note the sharply circumscribed leukocytic infiltration and destruction of the muscle fibers. Hematoxylin and eosin X100.

Figure 30.

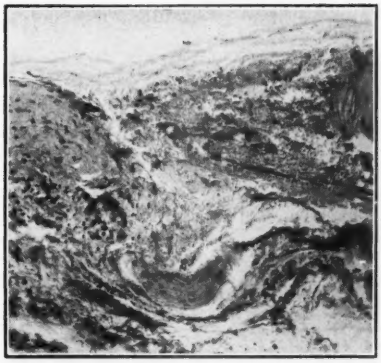


Section of the left posterior tibial nerve of Rabbit 746 injected intravenously with the culture from pyorrheal pockets in the case of multiple neuritis (Case 595). Note the marked leukocytic infiltration and the separation of the nerve fibers. Hematoxylin and eosin X200.

Figure 29.

Section of gasserian ganglion in Rabbit 908 injected with the culture from pus about the teeth in the case of trigeminal neuralgia (Case 674). Note the hemorrhage and leukocytic infiltration. Hematoxylin and eosin X100.

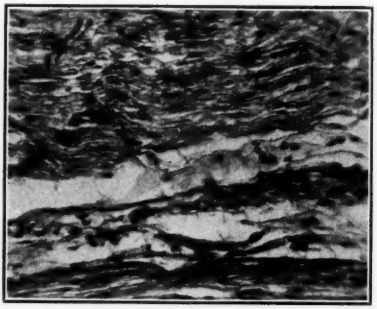
Figure 31.



Section of anterior crural nerve of Guinea Pig 133 injected intraperitoneally with culture from pyorrheal pocket in the case of multiple neuritis (Case 595). Note the hemorrhage and leukocytic infiltration. Hematoxylin and eosin X120.

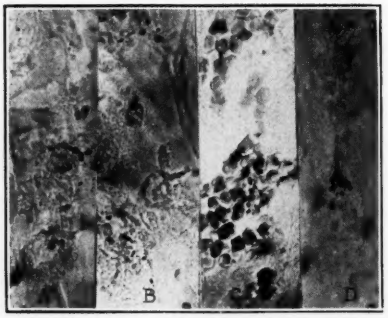
PLATE IX.

Figure 32.



Section of the left internal popliteal nerve of Guinea Pig 158 injected intravenously with culture from pyorrheal pockets about the teeth in the case of multiple neuritis after one animal passage. Note the edema, hemorrhage, and leukocytic infiltration between the nerve fibers Hematoxylin and eosin X220.

Figure 33.



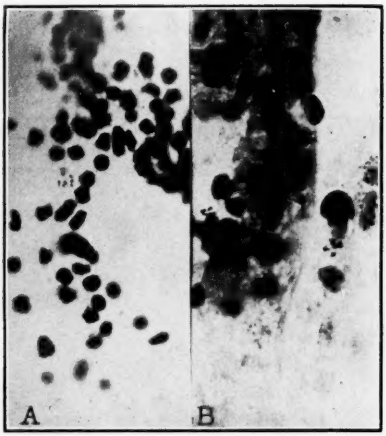
A. Section of hemorrhagic and edematous peridental membrane of a tooth of Guinea Pig injected intravenously with a culture of streptococcus from the foul dental pulp in a case of pulpitis, dental neuritis, and myositis. Note the large number of diplococci. Gram-Weigert X1000.

B. Diplococci in the vagus ganglion in a rabbit injected intravenously with a culture of streptococcus from a case of pulpitis, dental neuritis, and myositis associated with marked vagotonic neurosis.

C. Diplococci in the hemorrhagic area of the sympathetic ganglion in the same Rabbit.

D. Diplococci in the area of infiltration in the muscle shown in Figure 28. Gram-Weigert X1000.

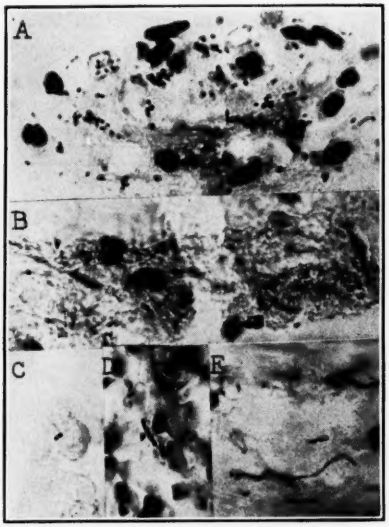
Figure 34.



A. Small diplococci in the hemorrhagic and edematous area of the gasserian ganglion shown in Figure 24.

B. Small diplococci in the sensory root of the gasserian ganglion in the same animal. Gram-Weigert X1000.

Figure 35.



A. Diplococci and leukocytes in the right musculo-spiral nerve of Rabbit 739 injected intravenously with a culture from the pyorrheal pockets in a case of multiple neuritis (Case 595).

B. Diplococci in the edematous area of the nerve shown in Figure 32.

C. Diplococci in the area of infiltration shown in Figure 30.

D. and E. Chains of diplococci in the hemorrhagic and edematous areas in the nerve shown in Figure 31. Gram—Weigert X1000.

Figures 36 to 46, inclusive, illustrate the findings in the case of pulpitis, dental neuritis, and myositis. (41)

PLATE X.

Figure 36.

Rabbit showing lacrimation of the left eye and swelling of the left side of the face forty-eight hours after the intravenous injection of streptococcus from the foul pulp.

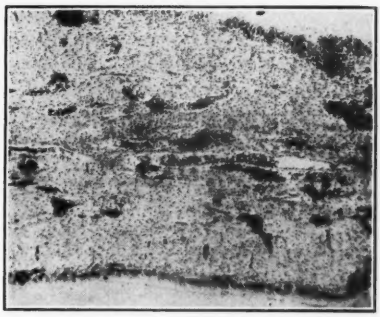
Figure 37.

Left lower jaw of Rabbit injected three days previously with 5 c. c. of twenty-four hour tissue-ascites fluid culture of the streptococcus from the tooth. Note the edema and hemorrhage in the periosteum opposite the root of the canine and surrounding the inferior dental nerve at the foramen of exit. X2.

Figure 38.

The pulp of the inferior canine and inferior dental nerve of a dog two days after an intravenous injection of the streptococcus isolated from the pulp. Note the numerous large and small hemorrhages of the left lower pulp and nerve. X2.

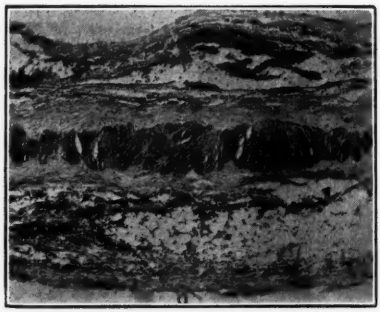
Figure 39.



Section of the pulp of the left lower canine shown in Figure 38. Note the marked hyperemia and the large and small hemorrhages. Hematoxylin and eosin. X60.

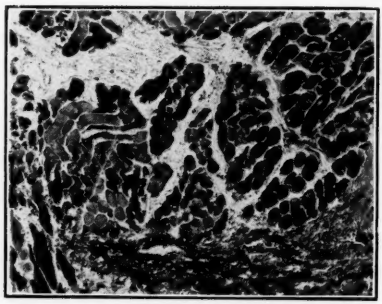
PLATE XI.

Figure 40.



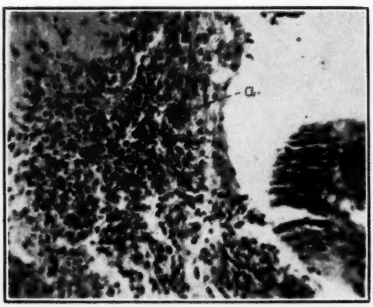
Section thru the hemorrhagic area in the left inferior dental nerve, shown in Figure 38. Note the marked edema and large and small hemorrhages and leucocytic infiltration of the sheath. Hematoxylin and eosin. X60.

Figure 42.



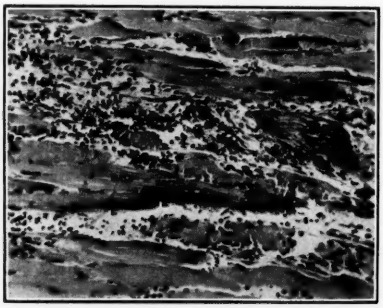
Section of the muscle excised from the left side of the patient's neck. Note the marked infiltration by connective tissue, the irregular staining and the atrophy of muscle fibers. Hematoxylin and eosin. X60.

Figure 41.



Section of the dental pulp of the left upper molar in Guinea Pig injected intraperitoneally two days previously with the streptococcus from the pulp of the patient's tooth. Note the marked leucocytic infiltration and hemorrhage. Hematoxylin and eosin. X240.

Figure 43.



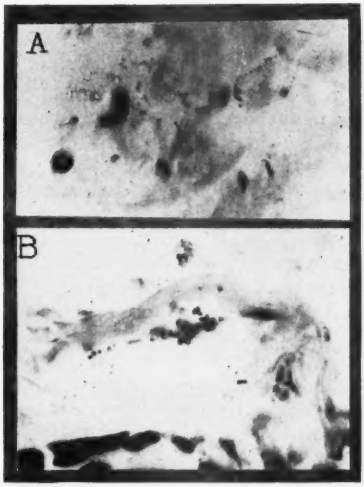
Section of the left triceps of Guinea Pig injected two days previously with the streptococcus from the muscle of the patient. Note the marked hemorrhagic and leucocytic infiltration and separation of muscle fibers. Methylene blue and eosin. X140.

PLATE XII.

Figure 44.

Diplococcus in infiltrated area shown in Figure 43. Gram-Weigert. X1000.

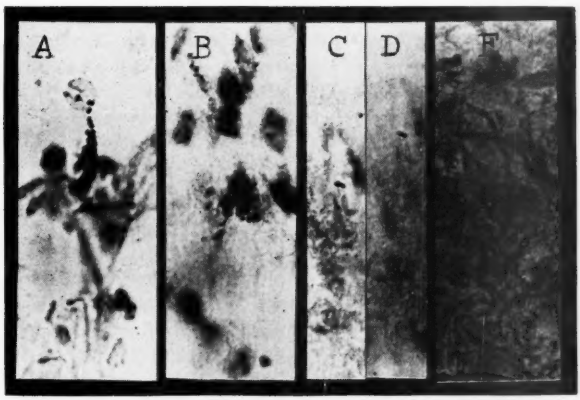
Figure 45.



A. Diplococci, singly and in short chains, and two leucocytes in tender fibrous node in the deep facia from the left side of the neck. Methylene blue and eosin. X1000.

B. Diplococci within the lumen and in the wall of the blood vessel and within the leucocyte just outside of the blood vessel in the center of the tender fibrous nodule of the deep facia from the left side of the neck. Gram-Weigert. X1000.

Figure 46



A. Diplococci and double chain of streptococci in the hemorrhagic and infiltrated area (a) in the sheath, shown in Figure 40.

B. Diplococci, singly and in short chains, within and outside leucocytes, adjacent to the area of hemorrhage shown at (a) in Figure 39.

C. and D. Diplococci in infiltrated area (a) shown in Figure 41. Gram-Weigert. XI000.

E. Diplococcus in an area of hemorrhage in the left superior dental nerve of Rabbit shown in Figure 36. Gram-Weigert. XI000.

Discussion.

E. E. Irons, M. D., Chicago, Ill.

Two points which seem worthy of special discussion, are the interpretation of results in experiments such as these, and the importance of co-operative study of infections of the mouth in their relation to disease.

1. In carrying out experiments on animals, in the attempt to reproduce conditions found in man one meets with some very curious combinations and coincidences. When we speak of elective localization it seems important to define just what is meant, whether some peculiar quality by which the bacterium seeks out a special type of tissue is which to reside, or whether we mean a combination of physical and chemical circumstances which taken together with oxygen and other growth-requirements of the organism determine its immediate death or allow its growth.

Doctor Rosenow has referred to tall agar tubes which furnish varying degrees of oxygen tension, and in which some bacteria grow at the bottom, some at the top. This growth of certain bacteria at some particular point of the tube might also be termed elective localization, with respect to the test tube and in this sense there seems to be no question but what such localization of bacteria in the body does occur. Suitable food supply and protection from the unfavorable destructive action of body ferments present in the blood and tissues no doubt determine to a large extent the fate of bacteria which circulate in the blood stream.

When so small an amount as 1 c.c. of a suspension of bacteria is injected intravenously in a rabbit, millions of bacteria are placed in the circulation either singly or in clumps, and are carried to all parts of the body. Many are destroyed en route. The fate of those which lodge in fine capillaries depends in part on their resistance to ferments of their host, and on the degree of protection afforded therefrom by their site of lodgment. The physical grouping of the bacteria, whether single or in clumps will have some effect on the number of visible hemorrhages which result from capillary embolism. The resistance of tissues themselves to the invading bacteria will also be a factor in determining whether the bacteria are quickly killed, or begin to grow. Thus bruised tissue, and tissues previously injured by disease may be less resistant than normal tissues, and may, owing to interference with blood supply, offer conditions of oxygen tension different from normal tissue, and thereby be a more favorable culture medium. It seems quite reasonable to suppose that changed environment of bacteria either in the body or in the culture tube may lead to changes in their growth requirements, so that the same conditions under which they were barely able to survive and to produce low grade almost symptomless lesions in the body, may later allow of greater growth, and more serious lesion in the host or on the other hand, preclude any growth whatever.

The earlier after intravenous or other injection that animals die, the more likely are the lesions found at autopsy to have been determined by mechanical and physical factors, rather than by those of growth reactions. Especially is this true in animals that die within the first twenty-four hours, in which the part played by fortuitous embolism must be a large one, and would seem to call for a particularly critical and cautious interpretation of the lesions found.

2. Experimental studies and clinical observation have made possible great progress in our knowledge of the relation of dental lesions to systemic disease. We may with profit pause and take the bearings of our present situation. Dentists and physicians have in the past three or four years come closer together than ever before, to their mutual benefit. They are now in general doing

good team work because each profession understands better the problems of the other. There is no doubt that many cases of arthritis, and myositis have been relieved, and many eyes saved, and the general health of many patients improved thru their reference to dentists who have corrected bad mouth conditions. One error for which the physicians are mainly at fault, is that arising from a tendency to make incomplete examinations. A patient complains of arthritis or other pain, his physician looks in his mouth, sees a few crowns, and at once says: "it's your teeth," and advises their sacrifice, and the conscientious dentist has great difficulty convincing the patient that his crowns are on sound roots. Now the fact is that in a case of this sort, the physician may be right, but taking all chances together, he is more likely to be wrong. What he should do is to give the patient a very careful and complete examination with the cooperation of the dentist, and then decide upon the course of action Some years ago many alveolar abscesses remained undiscovered and undisturbed. When the dental and medical profession discovered their omission, they went to the opposite extreme. Undoubtedly alveolar abscesses should of course be relieved, but expert dental judgment is required before condemning teeth on imperfect radiographs, which seem to show slight losses of bone density at their apices. After a tooth is extracted you cannot put it back as it was before.

Some interesting facts which may have a bearing on dental pathology appeared in the study of some 200 cases of iritis. Between 30 and 40 of these cases showed alveolar abscesses which had to be considered as possibly the etiologic cause. In a considerable number of these, however, chronic tonsillar infection was also present, and after a consideration of all facts, the question had to be seriously entertained whether the lesions of teeth as well as of the eyes were not secondary to tonsillar infection.

There seems to be no doubt but that oral sepsis may give rise to general infection, with bacteria demonstrable in the blood, even without evidence of localization in joints or other tissues.

Oral and dental hygiene is one of the biggest social problems of today and offers great opportunities for improving the general health of the population. The numerous dental clinics, especially the school clinics testify that this opportunity is being taken by the dental profession.

The medical profession are only beginning to appreciate their good fortune in being able to avail themselves of the advice and assistance of dentists, and the relations of the two professions are bound to become increasingly close and cordial.

Joseph L. Miller, M. D., Chicago, Ill.

Members of the Chicago Dental Society: I think we can all appreciate, after listening to Dr. Rosenow's paper, the tremendous amount of work which he has performed upon this subject. When we consider the amount of work he has stimulated in others, we can perhaps appreciate in a measure what he has done on the question of focal infection. Dr. Rosenow very wisely stopped when he said he has carried this out experimentally. He leaves it to the clinicians to determine what is the value to be derived from this from a clinical standpoint.

Being a clinician I feel that the members will be interested in getting, at least, my attitude towards his subject. After all the subject which interests our society tonight, altho it has not been brought up, is what is the result of the removal of these foci of infection on systemic infections, chronic myocarditis, chronic nephritis, and more especially, chronic arthritis. After all, chronic arthritis is the condition which stands out most prominently as a condition due to focal infection. What we are interested in is what happens to these patients

with chronic arthritis after we have removed all these foci of infection, that is, do they get well? Before considering that more carefully we must know what happens to chronic arthritis when untreated. Formerly we believe that every individual who developed arthritis had acquired a condition which was a progressive one. The next year would see that patient worse, the following year still worse, and the next year an invalid. Now we know that is not true. Many of them get well without treatment. Many have remissions of two or three years when they feel well and only a small percentage progress to the point of complete disability. This point is very important—or must know what happens to untreated chronic arthritis cases. Many heal spontaneously; many of them have remissions for two or three years, and a certain number are progressive.

Inasmuch as this disease runs in this way, there is only one way in which it can be studied and that is by controls. If you have a disease which always ends fatally you do not need a control. If you are treating a case of carcinoma, you do not need a control. In going thru the literature I have yet failed to find any series of cases of treated chronic arthritis where they have had controls. The literature does not contain a large series of cases which have been treated and another large series untreated. All are reports of treated cases. I have seen in the last two or three years a large number of cases of chronic arthritis both at the office and at the County Hospital and I have just as much pessimism when a patient with chronic arthritis comes into the office today as in the days before we knew anything about focal infection. This pessimism is not an original sin. It is acquired, the result of experience when I have had these patients thoroly examined, sent them to the dentist and had the dentist do what he thought wise, had the nose and throat man do what he thought wise, and the genitourinary man do what he thought wise, and have observed what a small percentage showed improvement more marked than the cases in which you did not do anything. I think you must bear in mind that we cannot lay too much stress on statements of the patient. The patient is naturally optimistic. When you tell a patient very emphatically that when he gets his teeth out, he will be better, he is usually better. The same thing when you take out tonsils. In six or eight hours after the operation he will tell you that his joints are better than they have been in years. Later when you get the patient in the office and compare the joint condition with what your records showed at a previous examination, then your mind becomes rather disabused. When you see that patient a year or two later, you are still of the same opinion. After all, the actual benefit that the patient has derived is surprisingly little. I am speaking of chronic arthritis and not acute arthritis. When we rule out what happens to the patients who are untreated we have very little to show for the value of removing the foci of infection in cases of chronic arthritis. I had one case three years ago, a woman who had very bad arthritis for a long time and very bad teeth. She had her teeth fixed up by a very competent man. I saw her six months later. She was optimistic and was very much better and thought she was soon going to be well. I really thought I had demonstrated the real value of such a procedure. A year later the patient came in quite as bad or more disabled than she was formerly.

To show the chronicity of these conditions we had at the County Hospital a few days ago a laboring man with chronic arthritis. He is still working and he has had chronic arthritis since the Franco-Prussian War. He was a soldier in the German Army in 1870,

and he has had arthritis ever since and still able to do a fair amount of work. I only mention that to show the chronicity of the condition.

I think it is up to some one in order to convince us to take a series of cases of arthritis and carry them along for two or three years without special treatment, and a similar series where you remove all the foci of infection and then at the end of one or two years compare the two series and see what happens. Then and only then will we have real evidence.

I think we must go very slowly on this question of extracting teeth for systemic infection. What I say to these patients is this, "Go to your dentist; if he says have your teeth removed, have them removed. At least you will get rid of something that is a menace to you. You will get rid of something that is probably undermining your general health. I will make no promise that that will cure your systemic condition, but if I had your teeth, I would have them taken out." I think we should be very careful about making promises as to the result of this treatment. I dislike to be pessimistic before an audience like this, but this is not an imaginary pessimism. It is a pessimism that comes from the result of close observation over a number of years and especially of chronic arthritis cases after they have had these foci removed. I am convinced that the medical man should leave the dentist alone as to what he should do with the mouth. I have felt very sorry for the dentist in his present position, because there are so many medical men who assume that all illness comes from the teeth. I saw a woman recently who had fallen down stairs and injured her leg and because the leg was still sore, she was sent to the dentist to have her teeth pulled. I think it is the duty of the dentist to stand firmly on what he thinks is right and base his decision on what the teeth show, without any regard to the patient's general condition.

Charles S. Williamson, M. D., Chicago.

I suppose it has filtered into the minds of everybody in the society that we have listened to a classic this evening. Now being just a clinician I am not in a position to discuss the bacteriologic side of it, but the whole question of focal infection has interested me. It is not as new as some of us think. When I was listening to Dr. Rosenow, I could not help but think back ten or twenty years when we saw cases of pyemia after antrum infections and after suppurating hemorrhoids. In those days we spoke of them as cryptogenetic sepsis. Now we speak of them as focal infections, especially if the source is an inconspicuous one.

I think, as Dr. Miller does, that Dr. Rosenow was very wise when he stopped on the firm ground of experimental evidence. The clinician gets a different problem. Mrs. A. comes into your office with a knee that is giving her trouble. Mrs. A. is 45 or 50 and has a tooth or teeth of doubtful quality. She has tonsils, which she explains to you light up every once in a while. She has vague digestive disturbances, which might be due to a gastic ulcer, gall-bladder or appendix. After I have taken as careful a history as I can and have gone over her from top to toe, and after I have sat down in the privacy of my study and thought it over from all angles, I confess that over and over again I have just been unable to know where to begin with the focal infection question. The teeth perhaps are at fault—I invariably send them to a dentist and leave it to the dentist to decide after we confer what should be done with the teeth. If it is a systemic infection and the infection is a serious one and my dental colleague says that the trouble is with the teeth, then I have the teeth pulled out. The local condition should be the deciding factor, giving due consideration to the fact that another focus exists elsewhere, which may be caused by the teeth.

Now I became extraordinarily interested in the subject of focal infection, thirteen or fourteen years ago, thru a very striking case that may not be amiss to relate I was called to Ohio to see a youngster of 12 or 13 with a horrible acute case of nephritis, as bad a case of acute Bright's as I have ever seen. The boy had had everything in the world done for him and there was no obvious cause for the acute Bright's, no scarlet, no acute tonsilitis, none of the ordinary causes of an acute Bright's. I spent two days down there and then told the father very frankly that while the diagnosis of acute Bright's was plain enough, the cause was obscure. He got over it however and came to Chicago. The boy had had for years what was diagnosed by men on both sides of the Atlantic as a "hysterical temperature". There seemed to be no findings to cause that temperature. I could not find any cause. Tonsils were not as scarce in those days as they are now. I had the boy consult a specialist who took out his tonsils and in the bottom of each was a definite abscess. At any rate, his temperature disappeared and he has been well ever since.

It is difficult for the average dental man to have patience with us and with the mistakes we have made and we are bound to make in our treatment of cases of arthritis. Perhaps Mrs. A's tooth is out and she has a period of relief. After having sacrificed two teeth the net results are that the knees are just where they were before. Now, seriously, gentlemen, this is an awfully difficult problem. Dr. Miller quoted a case from the County and I will quote an equally striking one. Three or four years ago a man of middle age came into my ward at the County Hospital. Going down the ward with the interne, I asked him what the case was and he said just an ordinary rheumatism. I did as a good many men do, I made up my mind that I would look him over carefully, but did not do it. The interne said one day, "This case had a little bursa on the elbow and I made a culture". "What did you find"? "Streptococci and from that we made a vaccine and I think the man is improving". The case then just fell out of my sight. About three weeks later we changed internes and the new interne said to me, "Would you mind coming down and looking over this man"? I looked him over and saw as pretty tophi in his ears as you would want to see. It was a clean cut case of gout. I have a patient now from New York who had all his teeth extracted also—a clean cut case of gout with his ears full of tophi. That shows you the difficulty of judging cases and the difficulty of judging results. As Dr. Miller said, it is up to somebody to report a series of cases untreated and a series after removal of the various foci which may be found.

I am not quite as pessimistic as Dr. Miller, but my experience has been practically the same. In the acute cases one does see some brilliant things happen and occasionally they are so striking that in spite of the comparative rarity of such occurrences one comes to the conclusion that there is a cause and effect relation. After having sent the case to the dentist and to the urologist and having the case cleared up and then seeing it go along for a while and then get a recurrence of the trouble, it is difficult to get enthusiastic about the clinical results, always bearing in mind that a secondary infection may occur. We know it is possible after removal of the primary focus to have a secondary infection occur, which acts then as a further source. We are right in the middle of a great epoch and we are in about the same position as the physicians of thirty years ago; we are too near to get the proper perspective. The best we can do is to get a tolerably correct idea. The one safe thing to do, looked at from the dental standpoint, is to watch the teeth from a prophylactic standpoint. I agree with Dr. Rosenow

that the "cure" of these medical conditions lies in their prevention. Once having allowed infection to get into the circulation thru that faulty socket, once having allowed it to form a metastatic infection elsewhere, it may be too late to close the door when the horse has been stolen. I think our medical men need closer cooperation with dental profession.

Dr. E. C. Rosenow (Closing): The attitude of the dental profession regarding the relationship between foci of infection and systemic disease at present is comparable to that of the medical profession a number of years ago. The results of the experiments presented are so striking and so significant that without the warning note contained in Dr. Iron's, Miller's and Williamson's discussions too much is apt to be expected in the way of practical results from the removal of dental foci of infection. On the other hand, the experimental evidence is of vastly greater fundamental significance as to the general truth of the causal relationship than clinical observation, particularly if this is made in chronic conditions such as arthritis deformans. It is becoming established that mere extraction of infected teeth does not necessarily eradicate the infected area. I have recently had this brought to my attention in some cases of chronic arthritis, and I wonder whether this might not explain in part the lack of improvement in some of Dr. Miller's cases. In conditions where anatomic changes have gone to the point beyond repair, where mechanical injury constantly occurs, as in chronic arthritis, where the systemic infection has been thoroly established, where the patient has become hypersensitive, and where a vicious inter-relationship between the host and micro-organism already exists, as I have shown, the removal of one or more foci could hardly be expected to result in an outspoken clinical cure. But to conclude that because of the apparent lack of improvement in these cases that there is no causal relationship between a chronic dental focus of infection and systemic lesion is of course not in accord with the experimental evidence, and the numerous instances where striking improvement has followed in conditions which have not become so thoroly established. The error which has been made is not an error in idea, but an error in promising too much following the removal of foci of infection. I meant to convey this idea in speaking of the patient in whom living streptococci were demonstrated in a metastatic lesion in muscle during the quiescent interval. Dr. Miller's attitude that eradication of dental foci of infection should be decided entirely by the local conditions without regard to the general health of the patient, if followed as long as the practice of dentistry is directed almost solely toward the preservation of the teeth for cosmetic and mechanical purposes, is sure to result in much harm. But if it is carried out in the new dentistry which is destined to have as one of its chief aims the prevention and cure of disease by ridding patients of dental infections because they are filthy, unsanitary, and detrimental to health, his view might be permissible. It seems to me, however, that the best solution of this problem will come from the close coöperation and the combined efforts of the two professions.

ANATOMICAL MEASUREMENTS RELATIVE TO CONDUCTIVE ANESTHESIA WITH PROCAINE AND ALCOHOLIC INJECTION FOR TIC DOULOUREUX.

By William A. Cook, D.D.S., Detroit, Mich.

UNDER this title are given the findings resultant from a series of measurements and observations on 100 dried adult skulls and mandibles. The skulls and mandibles measured are those used in teaching osteology in the Medical Department of the University of Michigan, and are tabulated that they may be readily referred to. On each of the 100, fifty-two measurements and notations were made.

The main object in compiling these charts was the establishment of facts and landmarks relative to conductive anesthesia with procaine, and alcoholic injection for tic douloureux. And with the exception of the infraorbital the technic in each case is the same for alcoholic injection as for conductive anesthesia.

The measurements which are of greatest interest under this title are those relative to the distribution of the maxillary and mandibular divisions of the fifth or Trigeminal nerve.

All measurements were made with accurate instruments, which included:

(1) A system of revolving, parallel planes and lines, and a triangle of 90°, 45° and 15° for the establishment of angles.

(2) A pair of steel dividers (calipers) and

(3) A millimeter ruler.

We will first consider the measurements for determining the location of the mental foramen.

These measurements were made by placing one point of the dividers on the inferior border of the mandible and the other point on the inferior border of the foramen, and measuring the spread of the dividers on a millimeter ruler. The combined notations establish the fact that the foramen is very constant with the inferior border, and by observation it is readily seen that it is very inconstant with the superior border of the mandible. In edentulous jaws the foramen may open immediately on the superior surface (Figure 1) and in others it may be 25 millimeters (Figure 2) to the superior border.

In the 100 mandibles, totaling 200 foramina located, 176 of the foramina fell within the limits of 11 mm. and 15 mm. from the inferior border of the mandible. This shows a variation of only 4 mm. in 7/8 of the cases. Of the remaining 24 foramina, 18 were 16mm., 3 were 17 mm., 1 was 20 mm., and 2 (in the same mandible) were 9 and 10 mm. respectively, above the inferior border of the mandible.

In making a hypodermic injection for mental conductive anesthesia, the needle should be projected in a line parallel to the bucco-lingual plane of the long axis of the second bicuspid, and in the line of the foramen (slightly anterior to the apex of the second bicuspid). Eliminating the one mandible, the foramina of which measured 9 and 10 mm. respectively, and taking 11 mm. as the minimum distance of the foramen

above the inferior border of the mandible and 2 mm. as the diameter of the foramen, then in proceeding with the injection from a point slightly anterior to the second bicuspid the foramen will have been found in 100% of the cases, when the needle has reached a point 13 mm. above the inferior border of the mandible, because all of the foramina above that point will have been found as the needle proceeds in contact with the bone from the point of injection to that point.

To have an accurate technic, the point of injection should be marked by

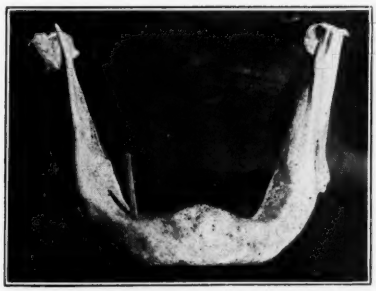


Figure 1.

Figure 2.

touching the end of an applicator which has been touched in phenol to the spot, and a point 13 mm. from the inferior border of the mandible should be marked with a pencil on the external or skin surface and the distance measured with dividers. (Note. An allowance of from 2 mm. to 4 mm. should be made by the operator for the covering of the mandible.) A guard should be placed on the needle at a corresponding distance, to avoid making too deep an injection.

Then starting the needle at the marked point and keeping the bevel of the needle in close contact with the bone and proceeding carefully, the needle will fall within the foramen, somewhere between the point of injection and the point 13 mm. above the inferior border of the mandible.

When the guard reaches the point of injection then the needle is 13 mm. from the inferior border of the mandible.

In 46½% of the cases the needle will be within the foramen when it has reached that point, and in 88% it will be found within the limits of 13 and 15 mm.

The mental foramen cannot always be located in the line slightly anterior to the apex of the second bicuspid. It varies and may be distal to the second bicuspid, but it will be found slightly anterior in at least 90% of the cases. Attention is also drawn to the fact, and it should be borne in mind that the window of the mental foramen in 89% of the cases, opens slightly to the distal (varying up to 300), 8% opens laterally, and only 3% open anteriorly. Therefore, to penetrate it, the needle should come from above (at a right angle to the mandible) and *not* at an angle from the mesial.

The measurements and observations, relative to the mandibular sulcus, are very interesting. The mandibular sulcus is the name given to the depression in the inner surface of the mandible immediately adjacent to the inferior alveolar foramen, and described as one centimeter in diameter. The inferior alveolar nerve occupies the center of the sulcus.

It is conceded that to produce man-

dibular anesthesia, the anesthetic should be deposited within the sulcus, and that the best results are obtained when the anesthetic is deposited at the center of the sulcus.

One making a study of a large number

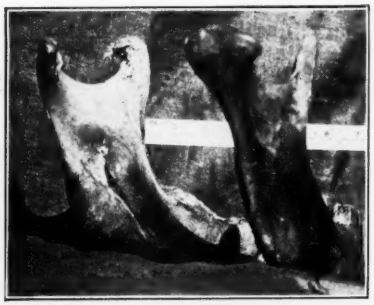


Figure 3.

of mandibles is struck with the wide variations.

In the discussion of these points, the findings of a series of three measurements will be used.

(1) From the external oblique line to the internal oblique line.

Figure 4.

(2) From the external oblique line to the center of the sulcus.

(3) From the external oblique line to the posterior border of the ramus.

The measurements for the first were made by laying a straight edge across the two external oblique lines and measuring with a mm. ruler projecting at right angles from the straight edge, to the internal oblique line. This distance is very inconstant, ranging from 1 mm. (Figure 3) to 11 mm. (Figure 4).

It was also observed that the distance from the internal oblique line to the center of the sulcus is extremely variable, in some instances the internal oblique line practically ending in the lingula. (Figure 4.)

The extreme inconstancy of the internal oblique line has led the writer to the opinion that it (the internal oblique line) should be eliminated as a landmark in the technic for mandibular conductive anesthesia, except to palpate for passing the needle by it.

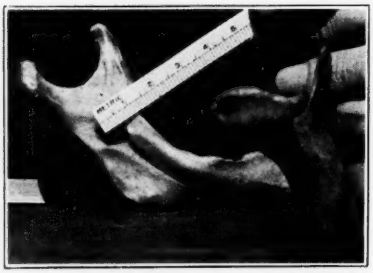


Figure 5.

2. The measurements from the external oblique line to the center of the sulcus, were made by placing the points of the dividers in those respective locations and measuring the spread with a mm. ruler. The charts show that this distance is also extremely inconstant, ranging from 13 mm. (Figure 5) to 27 mm. (Figure 6) with all the variations between.

3. The measurements from the external oblique line to the posterior border of the ramus, were made in a similar manner, with the dividers and the mm. ruler, and the distance is variable in the same ratio, ranging from 20 mm. (Figure 7) to 41 mm. (Figure 8).

The reader will note that in these two

widely varying cases the center of the sulcus falls practically two-thirds of the distance from the external oblique line to the posterior border of the ramus.

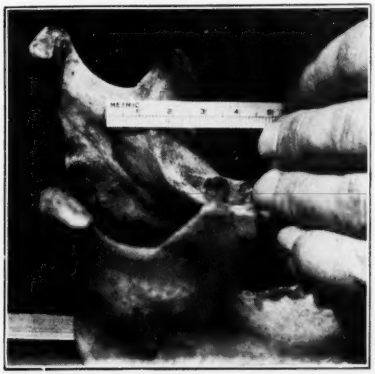


Figure 6.

The 200 cases measured, and all others which the writer has been able to observe, have shown that a point two-thirds the

Figure 7.

distance from the external oblique line to the posterior border of the ramus, falls within the width of the nerve of the center of the sulcus. This circumstance is constant, and establishes one of the most important facts in the technic for mandibular conductive anesthesia.

The writer believes that with the large number of measurements and observations made, the very important fact is established that it is possible to approximate the inferior alveolar nerve within the sulcus in every case of mandibular conductive anesthesia, by measuring the width of the ramus, with a ramometer. (Figure 9) and taking two-thirds of the distance as the depth of the injection.

In making this injection the needle should have a guard* (Figure 10) fixed at the proper distance, and the guard should be projected to the nucous

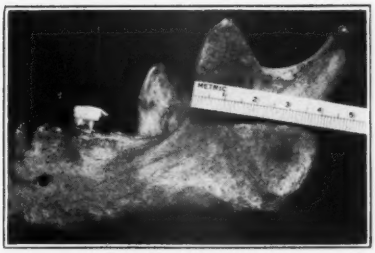


Figure 8.

fold, which will complete a triangle with the external oblique line and the center of the sulcus.

But in no case should the needle be projected more than 5 mm. beyond the measured depth, because of the danger of injecting into the parotid gland. The parotid gland enfolds the posterior border of the ramus, and with the narrow rami (as narrow as 2 cm.) there is great danger of this distance being exceeded, and the parotid gland injected. Also the posterior facial vein traverses the parotid gland at the posterior border of

*A small piece of vulcanite rubber can be used as a guard. This will not dissolve in alcohol so it can be kept sterile. The guard (piece of vulcanite) can be seen at the end of the glass tube into which the needle is projecting. The tube is calibrated in mm. for a distance of 5 cm. and is used to drive the guard to the proper place on the needle.

the ramus, (Sobatta-McMurrich), and is very easily penetrated, and it is the writer's opinion, that it is the injection of Procaine into this vein and its transmission by the blood stream to the brain, thereby producing a stimulation of the Medulla (vaso-motor center) producing a dilation of the abdominal blood vessels which causes a blood stasis. Not enough blood would be traveling to the brain to keep it supplied with oxygen, causing an anemia of the brain which is the prime cause for the synocope, dyspnoea, cyanosis and other unpleasant sequela, which have been more common and profound in mandibular anesthesia than in any other.

In all the literature on mandibular conductive anesthesia which the writer has been able to obtain, he has observed that from 1.5 cm. to 2 cm. have been designated as the depth of the injection.

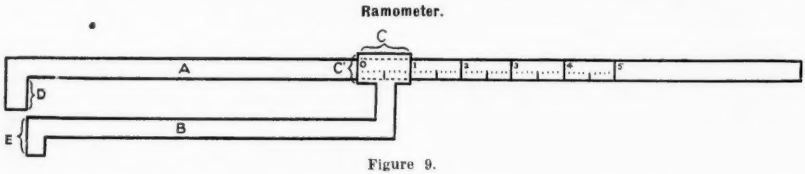


Figure 9.

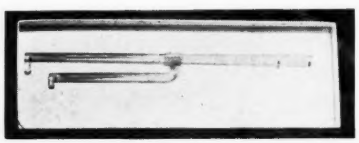


Figure 9-A.

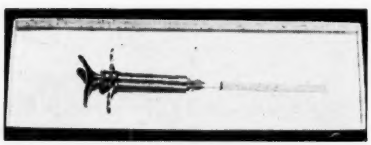


Figure 10.

Attention is here drawn to the wide variations in mandibles, and the reader will readily understand that it is unscientific to use any set distance as the depth of the injection and that in every case of mandibular conductive anesthesia a different depth of injection is required to reach the center of the sulcus, and that this distance should be determined in each case. Of the 200 sulci measured, in 74 cases the centers of the sulci were more than 2 cm. from the external oblique line, and 76 were less than 2 cm.; or 150 in 200, (75%), would not be reached in the prescribed 2 cm. injection. (Figure 9).

The ramometer consists of two parts, A. and B. A. slides thru the tube C. and is calibrated in mm. for a distance of 5 cm. C' stands at O. when the lines D. and E. fall in the same plane. B. goes inside the check and E. rests on the external oblique line. A. goes outside the check, and D. hooks over the posterior border of the ramus and the width of the ramus is read at C' the end of the tube C.

The next point to which the reader's attention is drawn is the method of determining the point of injection that will place the needle in the perpendicular plane of the mandibular sulcus. The instructions have been that the point of injection should be 1 cm. above the plane of the teeth or 1 cm. above the last tooth. The extreme variations in all proportions in mandibles, as the reader will note even in the few figures herein given, will again readily convince one of the inaccuracy of any set distance.

The writer has several mandibles in which the point of injection should be as low as the line of the plane of the teeth, and some in which the center of

the sulcus, (the proper point for depositing the anesthesia is 5 mm. below the line of the plane of the teeth, therefore requiring the point of injection to be 5 mm. below the plane of the teeth.) (Figure 11).

The writer also has mandibles in

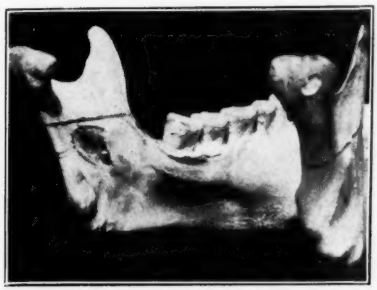


Figure 11.

which, if the prescribed point of injection (1 cm. above the plane of the teeth) is used, the needle will pass thru the sigmoid notch (Figure 12) or puncture the temporo-mandibular capsule.

Furthermore, there have been no in-

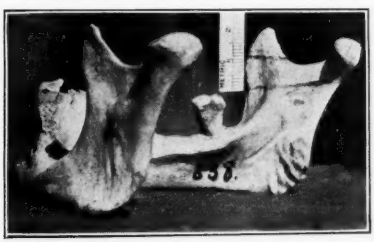


Figure 12.

structions to determine the point of injection in mandibles in which the posterior teeth were missing nor in edentulous mandibles. (Figures 1 and 5).

The writer has developed a technic for determining the perpendicular point of injection which is very simple and accurate. The reader will observe (Figure 13) that in the external oblique line of each ramus there is a distinct notch. Different types of mandibles, the rami of which are from the widest to the narrowest, and from the longest to the shortest, are seen in this picture, and in every one the notch is plain.

This notch is constant in all mandibles which the writer has been able to observe. In the mouth this notch is very easily palpated because the temporal ligament has its attachment at the superior bulge of the notch, therefore amplifying it.

This notch is the one important landmark for determining the perpendicular point of injection for mandibular anesthesia. The operator should stand in front of the patient and palpate the

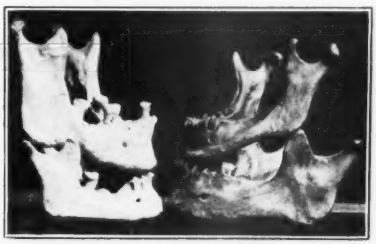


Figure 13.

notch with the thumb. The thumb is then turned inward *at a right angle to the ramus, to the internal oblique line.* These instructions should be carefully observed, *as the needle should always travel at a right angle to the ramus.*

If this technic is followed carefully the center of the thumb will point directly toward the sulcus, and therefore indicates the point and line of injection. This point may fall below the plane of the teeth, (Figure 11) or it may be more than 1 cm. above (1.7 cm. in Figure 14).

This technic has proven to be accurate, in every case the writer has been able to observe (about 400 rami).

The perpendicular location of the

sulcus is of extreme importance. When the regional anatomy is understood and the course of the inferior alveolar and lingual nerves is considered, then its full importance is appreciated. The inferior alveolar and lingual nerves descend from their bifurcation (slightly below the foramen ovale) downward along the medial side of the external pterygoid muscle, then turn outward and reach the ramus at a right angle, coming between the internal and external pterygoid muscles. Therefore the inferior alveolar nerve cannot be approximated for mandibular anesthesia at any point above or below the mandibular sulcus.

Figure 14.

The reader can readily understand then, that to reach the nerve and secure the desired anesthesia with the least amount of anesthetic, it must be deposited within the sulcus otherwise the anesthetist must depend upon a diluted anesthetic reaching the nerve by diffusion thru the tissues, and resulting in a partial, slow or no anesthesia, depending upon the distance from the sulcus at which the anesthetic was deposited.

The practical results obtained by following this technic carefully justify the writer in saying that there are no unseemly results from the injection of procaine for conductive anesthesia if it is done properly and that we are getting complete mandibular anesthesia, not in 15 to 25 minutes but in *three minutes.*

The measurements relative to the infraorbital foramen were made by placing one end of the dividers on the infraorbital ridge and the other end on the superior border of the formen, and measuring the spread on a mm. ruler. The charts of the 200 foramina measured, show this distance to vary from 2 mm. to 12 mm. In the skull on which the 2 mm. distance was found, there were two infraorbital foramina on the left side measuring 2 mm. and 3mm. respectively from the superior border of the infraorbital ridge; and in only one other skull was there a 3 mm. distance found. Following is a table of the measurements from the infraorbital ridge to the infraorbital foramin.

One was 2 and 3 mm. respectively.
One was 3 mm.
Thirteen were 4 mm.
Thirty-four were 5 mm.
Forty-seven were 6 mm.
Fifty were 7 mm.
Twenty-seven were 8 mm.
Eleven were 9 mm.
Ten were 10 mm.
Four were 11 mm.
Two were 12 mm.

The table shows that by allowing 3 mm. as the diameter of the infraorbital foramen, and making the injection at the reflex of the mucous membrane in the bicuspid region, and projecting to the foramen, the foramen will have been found in 99% of the cases somewhere in its course when the needle has reached a point 7mm. below the superior border of the infraorbital ridge and in 144 cases of the 200 it will be at the foramen, when it has reached that point.

The infraorbital foramen is located at about the middle of the inferior border of the orbit, and opens in a depression beneath the infraorbital ridge. The window of the foramen opens at an angle of about 45° mesially and downward

(Figure 15) or toward the ala of the nose. To make an infraorbital conductive anesthesia the foramen should be palpated and the point marked with a pencil. If impossible to palpate, a point 7 mm. below the middle of the infraorbital ridge should be marked with a pencil. The point of injection should be at the reflex of the mucous membrane between the first and second bicuspid, and this point should be marked with an applicator which has been touched in phenol. The distance between the two points should be measured and a guard

Figure 15.

placed on the needle at the proper position. The needle is then projected from the marked spot toward the infraorbital foramen, keeping the needle lightly in contact with the bone, and 1 c.c. of the anesthetic deposited as the needle proceeds and 1 c.c. should be deposited when the guard has reached the point of injection, which would place the enesthetic at the infraorbital foramen. Then the point of deposition should be carefully massaged to carry the anesthetic thru the anterior wall of the antrum and into the foramen where the anterior superior alveolar nerve is given off from the infraorbital nerve.

The point of injection to reach the posterior superior alveolar nerve and foramen for conductive anesthesia, is at the reflex of the mucous membrane 1 cm. posterior to the malar process. The measurements for this foramen were made by placing one end of the dividers at the foramen and the other end at a point 1 cm. posterior to the malar process and in a line drawn horizontally from the inferior point of the malar process (the malar process is palpable usually above the first malar).

This would be at the reflex of the mucous membrane.

The charts show the distance from this point to the posterior alveolar foramen to vary from 7 mm. to 20 mm. and that 89% of the foramina fall within the limit of 15 mm. from the designated point.

There is no method of determining the exact location of the posterior superior alveolar foramen but it is the opinion of the writer that an injection 15 mm. in depth, in this region, is sufficient to produce tuberosity conductive anesthesia. In some cases an injection just thru the attachment of the buccinator muscle would be sufficient, but it is impossible to locate the point exactly, therefore the 15 mm. injection is recommended.

The following technic is advised. Locate a point at the reflex of the mucous membrane 1 cm. posterior to the malar process. Insert the needle at this point and project it at an angle of 45° up and back keeping the bevel of the needle close to the bone for a distance of 15 mm.

One-half c.c. of a 2% procaine solution should be injected as the needle proceeds, and the remainder of 1 c. c. (one-half c.c.) should be deposited when the 15 mm. depth is reached. This would produce dental anesthesia, in the whole molar region, unless there was an innervation in the first molar region, from an anastemosis from the middle superior alveolar nerve in which case anesthesia could be produced by an infiltration in canine fossa.

For surgical anesthesia in the molar region another injection at the posterior palatine foramen is necessary.

Zygomatic.

The measurements for the zygomatic or spheno-maxillary injection were made with the same instruments and in a similar manner as heretofore described, and again the wide variations will not permit of a set distance being prescribed for the depth of the injection.

Complete dental maxillary anesthesia can be produced by depositing the anesthetic at the entrance of the maxillary nerve into the infraorbital canal, (in the spheno-maxillary fossa). This point is the most convenient and most practical for injecting for complete dental maxillary anesthesia.

The depth of this injection can be determined by comparative measurements. First, the point of entrance of the infraorbital nerve into the infraorbital canal, is directly posterior to the infraorbital foramen, and the nerve travels in practically a straight line in its course across the floor of the orbit. If this line is bisected at right angles by a plane, that plane will pass thru a point at the reflex of the mucous membrane 1 cm. posterior to the molar process. Since this plane bisects the line, then any point on the plane is equidistant from its two ends (the posterior end of the infraorbital canal and the infraorbital foramen), therefore the distance from the point of injection (1 cm. posterior to the molar process) to the infraorbital foramen is equal to the distance from the point of injection to the posterior end of the infraorbital canal (the proper point for depositing the anesthetic) and is therefore the proper depth for the injection.

To make this injection the curved hub of the Fischer type syringe should be used. To produce maxillary conductive anesthesia the point of injection should be determined as described and marked. The distance from this point to the infraorbital foramen would be the proper depth to make the injection. This distance should be determined with calipers and measured and a guard placed on the needle at the proper position. The injection is then made and the needle kept lightly in contact with the bone, and projected in the plane described by the point of injection and the line from the posterior end of infraorbital canal to the infraorbital foramen, until the guard reaches the point of injection (1 c.c. of 2% procain solution produces complete maxillary anesthesia.)

These injections should be made only with a full knowledge of the anatomy of the region and the observance of surgical asepsis in all that it means.

CHICAGO DENTAL SOCIETY.—PRESIDENT'S ADDRESS.

By Victor H. Fuqua, D. D. S., Chicago, Ill.

(Read before the Chicago Dental Society, Chicago, Ill., September 16, 1919.)

THERE is probably no dental society in the world richer in tradition and achievements than ours, or among whose membership are numbered so many names of illustrious authors, teachers, scientists and practical workers.

We are entering upon a new era in the dental profession; educational requirements, methods of teaching and practice are rapidly advancing. The Chicago Dental Society must advance with the times and not be content with past accomplishments.

During the past decade many voices have been stilled; hands become palsied and activities ceased among the men who have helped to make our society great. In order that we may be true to this great heritage, we must replace this spent talent with new. Our first aim and object should be to increase our membership to two thousand, to stimulate the interest of the members we already have and to gratify their desire for knowledge of the latest achievements in scientific dentistry by a carefully prepared program. Organization of special study clubs composed of small groups should be affected to take up special subjects such as Bacteriology, Pathology, Histology, Oral Surgery, Operative and Prosthetic Dentistry, Orthodontia, Prophylaxis or other subjects that may be of interest to the individual groups.

An especial plea is made to the component societies believing that the strength and progress of the Chicago Dental Society in the future will largely depend on their activity and support. Latent talent should be developed and encouraged to take active part preparatory for greater service in the parent body. Individual activity in work and study should be the one great aim and object of the component societies and it is suggested that more frequent meetings would be of benefit, and closer cooperation between the dental profession in Chicago and our dental educational institutions is especially desired. Postgraduate courses should be conducted only by educational institutions, eliminating some of the evils of special courses given by individuals. Definite plans should be perfected for the establishment and maintenance of municipal clinics.

The subject of Industrial Dentistry confronts us and it is of the greatest importance that the plans of its operation should be carefully formulated by and thru the unselfish interests of the dental profession, bearing in mind this great service to humanity in its relation to health and efficiency, encouraging and fostering public sentiment in the matter of Oral Hygiene.

In subsequent programs thruout the year it will be the aim of the officers and program committee to select eminent

men in the dental profession to present the most advanced ideas on such subjects as Oral and Plastic Surgery, phases of Prosthetic work, Pulp Conservation, Pulp Destruction, Root-canal Management, symposium on Oral Hygiene, Industrial and Municipal Dental Clinics, Outline of Educational Plans looking to the establishment of permanent Dental Infirmaries, Dental Economics, etc. Your President is but the instrument or mouth piece thru which our society speaks; his wishing, hoping and working for success will avail nothing without the active cooperation, suggestion and personal interest of every member.

No dental society, business, social or religious organization can thrive and prosper without having a definite plan and policy; therefore, I would summarize the aims for this year as follows:

I. Increase membership to 2,000; 25% increase in every component society, and a more efficient organization.

II. More efficient dental service to humanity and inauguration of better plans for education of the public.

III. Raising the educational standard of the individual dentist by organizing Study Clubs—Unit Clinics and presentation of authorative papers.

IV. The developing of a thrifty dentist, a better professional man and a patriotic citizen.

CLASSIFICATION OF JAWS AND A MODELING COMPOUND TECHNIC.

By George P. Brenner, D.D.S., Milwaukee, Wis.

(Read before the Illinois State Dental Society, Peoria, May 13-16, 1919.)

MORE thought and study than ever before are now being given to the construction of artificial dentures and especial attention is given to the taking of a proper impression since that is the foundation upon which the ultimate success of a denture depends. It is only a few years past that a clinic program rarely, if ever, had a number on taking impressions, but now a program is not complete without a treatise on some phase or other of this subject, and by stimulating this interest the ideal sought may ultimately be realized.

The very foundations for the construction of a denture were in the past left to a haphazard and unscientific technic. The dentures constructed after such technic would in some cases be a perfect success but for such patients as had worn dentures for a period of time were utter failures.

These embarrassing results were attributed largely to some mishap which could not be accounted for, or perhaps to the temperamental condition of the patient, never tracing the failure to the proper source, that is, lack of the proper foundation from which to construct the denture.

This immediately presents the problem of diagnosis, proving conclusively that different jaws must be treated according to their individual characteristics. Were this not the case then every denture would have to fit perfectly.

No denture is better than the impression from which the cast is constructed.

This brings us to the subject we wish to discuss this evening, that is, classification of jaws for diagnosis, influences that cause jaws to change, and a modeling compound impression technic for successfully handling these difficult cases.

It is only lately that any attempt has been made to study the bony formation and the condition of the mucous tissues of the jaws for the purpose of determining their relative value for supporting a denture.

No one discredits the fact that different jaws have a varied value for denture support. Were this not true we could readily adopt a technic which when accurately followed would produce uniform satisfactory results for every case, but the fact remains we have some few successes and many failures. A great majority of these failures are worn by a helpless dependent public, which failures slowly but positively destroy the denture supporting value of the jaws.

Why are some dentures failures? Remember a denture is not a failure that is pronounced unsatisfactory by the patient when delivered, because that denture is not worn and so can cause no injury; but the dentures that are worn by patients with the implicit faith that it is the best that can be made, resigning themselves to the inevitable that comes to many sooner or later, those are the cases where the great damage is done by reducing the jaw's denture supporting value.

I believe that jaws can be classified into two main groups.

First, jaws that have a favorable denture supporting value.

Second, jaws that have an unfavorable denture supporting value.

The favorable jaw acquired its form thru the normal resorption of the process after a normal extraction, and supporting well-fitting dentures with the force of mastication equally distributed, that is, occluding in a well-balanced form with a full opposing denture, either natural or artificial.

These jaws are described under the Supplee classification as Classes 1 and 2.

CLASS 1.

Uppers:

1. Muscular attachments connected high on the buccal and labial surface of firm ridges.
2. Vault covered with uniform layer of membrane.
3. Slight soft areas in rear third of vault on either side of median line.

Lowers:

1. Muscular attachments connected low on the labial and lingual border of the ridge.
2. Uniform layer of membrane over a prominent ridge.

CLASS 2.

Uppers:

1. Muscular attachments connected near the crest of firm ridges.
2. Vault covered with thin tensely drawn membrane.
3. Small areas of soft tissue in rear third of the vault, on either side of the median line.

Lowers:

Labial and lingual attachments connected near crest of ridges.

These two classes of jaws can be well fitted with any good scientific impression technic and are the cases that make denture construction a real pleasure.

The group of jaws that have an unfavorable denture supporting value or the troublesome ones, that require careful diagnosis and a definite technic to secure the maximum amount of denture efficiency, may be classified under Classes 3 and 4 according to Supplee.

CLASS 3.

Uppers:

1. Muscular attachments connected to the ridge thru areas of soft tissue, covering the buccal and labial surface.
2. Soft tissue overlying the vault varying in density.
3. Pronounced soft areas in the rear third of the vault, sufficiently yielding to be affected by muscles of the soft palate.

Lowers:

Buccal and lingual attachments connected to the ridge thru areas of movable soft tissue.

CLASS 4.

Uppers:

The predominant characteristics of Class No. 4 are a soft ridge in front, or flexible tuberosities, or both.

1. Labial attachments may be either high or low, but connected to the soft ridge.
2. Soft tissue under the membrane may be thin, heavy, or varying in density.
3. Movable soft areas in rear third of vault may be small and shallow or large and deep.

Lowers:

Buccal and lingual attachments connected to ridge thru soft membrane, with the same condition in the molar region.

A soft ridge is often very thin, ribbon-like and very flexible.

Other forms of jaws are those treated surgically for, first, diseased conditions; second, impactions; and third traumatic injury.

We will not discuss this class at this time because each case is an individual problem and must be treated as such; but I wish to deal in detail with Classes 3 and 4 to determine as to the cause of these conditions and a logical method of handling these cases.

It is natural to assume that jaws of Classes 3 and 4 belonged at some time in the past in Classes 1 and 2. All jaws had at one time a perfect denture supporting value with a normal bony ridge formation and a normal healthy mucous tissue, which, if properly treated and unabused, would have remained in that healthy, normal condition indefinitely, but they are now changed to this condition and this question naturally arises. Could this have been avoided had that jaw received proper denture service?

Do we ever carefully study the effect a denture constructed for a so-called green mouth, or a jaw having a perfect denture supporting value, will have upon its supporting base, the jaw? Do we carefully determine the position of the teeth in relation to the ridge and to the occluding teeth to properly distribute the stress of mastication? Have we uniform support on hard and soft tissue? Is the rim of the proper form and height to produce a perfect valve seal? Is there a valve seal back of the tuberosities? Has the denture been extended to proper length at the heel? And is the denture finished to a smooth, non-irritating surface with proper relief for the hard areas in the vault?

These are the requirements combined with proper esthetic effect for a perfect denture. But even such a denture's period of usefulness is limited, and this fact should be made clear to the patient. If any one or a number of these requirements are not complied with, the denture will be a failure for the reason that it will change jaws of Class 1 or 2 into Class 3 or 4.

We as dentists are not doing our duty toward our patients to the fullest extent by making perfect fitting dentures alone; but we should impress our patients with the importance of frequent examinations. This gives us an opportunity to carefully watch the jaws for any unfavorable changes that may take place and advise a refit of the denture when indicated. We must explain to patients contemplating a denture what to expect and what to do in order to retain continued denture efficiency and must eliminate the erroneous belief that a rubber denture can serve efficiently for a life-time.

We are all familiar with the soft ridge in front. This condition is produced by an incisal occlusion with no lower molars and possibly no lower bicuspids to distribute the force of mastication over the entire surface of the jaw. In this instance the upper denture may be perfectly adapted, but if no molar and bicuspid restoration is made on the mandible that perfectly fitting denture will be a failure, because the force of mastication is not equally distributed and the process in that region of the jaw resorbs, due to the excessive strain, and the jaw's perfect denture supporting value is lost.

Then the jaw with the loose flabby tissue on the labial and buccal, caused by either a well or poorly fitting denture on a so-called green jaw, but owing to the patient's neglect, or the dentist's fault in not instructing the patient to have the dentures refitted when necessary, it is worn longer than its period of usefulness. The normal shrinkage of the jaw after extraction is estimated at three-quarters from the labial and buccal side and one-quarter from the palatal side. It is evident, therefore, that a refit should in all cases be made before the soft tissues fill in the amount of shrinkage.

We have the denture with the imperfect periphery, imperfect seal back of the tuberosities, and too short at the heel, but held in place with suction devices or so-called air chambers, or perhaps, the skill of the patient. This causes a constant agitation of the

denture which inflames the mucous membrane to such an extent that it becomes sore and spongy wherever the denture is in contact with it. I also believe that a great deal of tissue change is due to interference with the free circulation in the palatine vessels caused by undue pressure of the denture. These sources of nourishment of the jaw should not be impaired but be allowed normal freedom by relieving the denture at the anterior and posterior palatine foramina.

Many are satisfied with the denture as long as it "sticks," as tho that were the only qualification, and pay no attention to the proper position and articulation of the teeth. Whenever you have one or more teeth striking harder than the rest of the teeth, the undue pressure will cause resorption of that portion of the process receiving the strain, the same as a full upper denture occluding with only the lower six or eight front teeth, and a soft ridge will develop as a result of this strain, saying nothing of the constant discomfort to the patient and its interference with proper mastication.

An impression is not the only essential for a perfect denture, it must have the added features of a correct relation of the teeth to the ridge, perfect anatomical articulation, and an unstrained bite.

Treatment—Before Taking Impressions.

When we are called upon to deal with an extremely soft ridge, i. e., one that is movable and flabby, I firmly believe that a surgical removal of this tissue is indicated because a better fitting and more stable denture can be constructed on a flat firm jaw, than on a jaw with a yielding support. A denture can be constructed on a soft ridge jaw that resists dislodgment, but it will not possess the same degree of efficiency that a denture would have with a solid base.

Patients are not always willing to have this soft tissue removed surgically and so we are called upon to employ such technic as will produce the best results under existing conditions.

When a case presents with inflamed or irritated gums, the rest treatment for three or four weeks has always served me best. To apply this treatment properly the dentures must be lined with a layer of modeling compound every three or four days so they can be worn at meal time or when absolutely necessary from a social standpoint, until the mucous membrane has been reduced to its normal healthy condition.

I wish to again call your attention to the importance of an occasional reexamination of your denture patients so those undesirable conditions can be avoided because "Prevention is better than a cure." The psychology of this treatment is very helpful. The patients realize that you are interested in their welfare, that you have their comfort and denture efficiency at heart.

When the patients are treated in this way it inspires a well merited confidence.

In order to successfully treat all cases as they come to your office, you must have more than one technic at your command and as soon as we as a profession realize the importance of this we will deliver better denture service. We use different technics on our operative work, then why not in prosthetics?

The two recognized technics today are the plaster and modeling compound technics. It is necessary to have a thoro working knowledge of these two technics in order to deliver the most efficient denture service possible in all cases.

The compound technic being the most difficult should be given special study and practice so as to develop skill and dexterity to manipulate it properly.

With it you can displace tissue favorable to the wearing of a denture, compress tissue, and get a perfect impression of muscles and tissues that change under biting stress.

We will now attempt a brief descrip-

tion of the Compound Technic for Classes 3 and 4.

Examine the jaw and make a thoro diagnosis. Examine the posterior third for soft and movable tissues, indicating whether displacement of tissues is necessary or not. Examine the buccal and labial sides of the jaw for muscle attachment—whether the muscles are strong and firm, or weak and covered with a soft, sub-mucous tissue. Pay special attention to the vault for hard areas and for spicule of bone which can only be felt under pressure with the finger. Also examine for soft flabby ridges.

The diagnosis complete, select a tray of aluminum either Supplee or Green tray of the proper size and fit the heel perfectly to the vault and have it extend back to the point that the finished denture is to be. In a normal mouth this is to the vibrating line of the soft palate, indicated usually by the Foveola Palatine. This line can further be detected by having the patient open the mouth and produce the sound "Ah, Ah." If there is a soft ridge in front, the heel of the impression must be carried back beyond the vibrating line covering the vibrating tissue to the extent of 1-32 or 1-16 of an inch, depending upon the compressibility of the anterior ridge.

The periphery of the tray should be carefully trimmed low enough so it clears any muscle action, and cut away entirely at either tuberosity, so as to be sure and not interfere with the free movement of the coronoid process.

In order to properly handle compound it is necessary to have the proper apparatus so that the temperatures may be properly controlled. You cannot heat compound in a dish of water on a gas burner in the laboratory, glaze this compound from a Bunsen burner at some other part of the laboratory, and utilize cold water from the faucet at the sink, and expect to get a compound impression. In order to properly handle compound you must have everything handy and in its proper place. These requirements are most advantageously met in the Supplee Compound Heater Unit No. 2. The dish is filled with cold water and the necessary compound placed into it; the heater unit turned on to high and allowed to run until the thermometer indicates 200 degrees Fahrenheit of the surface water. The water is then thoroly stirred with a spatula, which reduces the temperature to approximately 160 degrees. The heater unit is then turned down to low, which retains the surface water at 160 degrees and reduces the temperature of the water at the bottom of the dish to 140 degrees, at which temperature compound can be kept an almost indefinite period of time. At this temperature it is in good workable condition and always ready for use.

It is absolutely essential to have ice water at hand, since compound must be thoroly chilled before removing from the mouth. From the heater take a small portion of compound and thoroly knead. Then use a portion of compound the size of a walnut, varying with the size of the jaw, heat one side of this over the Bunsen flame until it sizzles, and quickly fasten to the tray. Then shape the compound to the approximate shape of the jaw, with the palatal portion in the form of a pyramid, and higher than the vault. Glaze uniformly the entire palatal surface of the compound, then drop it quickly into the hot water at 160 degrees to temper the compound and place into the mouth, guiding it into position with a firm, upward and backward pressure, being careful to center the tray and getting it back to the vibrating line. Hold firmly in this position for two or three minutes until the compound has cooled, then chill thoroly with cold water and remove. At this step we do not care whether the tissues have been overstrained or not. All we want, and all that is essential is a perfect impression of the vault.

Next take a roll of compound and

build a bite block on the back of the tray and establish the length of the bite and the occlusal plane.

We are now ready for our lower impression. There are various technics advised for a lower impression, and the various technics are indicated for various lower jaws. If you have a jaw of Class 3 or 4 with badly resorbed ridges, I prefer the Supplee technic. Take the Supplee Occlusal tray and form compound to it to the approximate shape of the jaw, with sufficient material to fill in the normal space between the lower ridge and upper bite block, glaze the surface, temper in water at 170 degrees, quickly place into the mouth, rather too far forward of the lower ridge, ask the patient to close the lips and swallow once, and keep the jaw perfectly quiet. This will give an impression of the lower jaw with the muscles in their most distended position due to the swallowing act which brings the tongue and sub-lingual tissues in their most distended position and the buccal and labial tissues in their working positions.

After this has thoroly cooled, remove and trim all surplus. This will give you an impression with tissues somewhat displaced, especially at the heel where the masseter muscles come into play when biting force is exercised. To get a perfect impression of these muscles, cut away the heel of the impression as far forward as the first molar position, add new compound from the heater which is thoroly softened, glaze again, quickly place into the mouth, and have the patient bite firmly and swallow a number of times at various intervals. This will give a perfect impression of the masseter muscle in its distended form with the mouth closed and under biting strain. The lingual rim of the lower impression will then show an angle which is formed by the lingual side of the lower ridge, and the base formed by the sub-lingual glands and tissues. This surplus is then trimmed to this angle and gives the approximate length of the plate on the lingual. This should in all cases where much resorption has taken place be trimmed to the milo-hyoid ridge and it may extend about 1-64″ beyond, if we have a good firm ridge. The buccal margin of the impression must be trimmed to the external oblique ridge, or the point of muscle attachment. Where a lot of soft, flabby tissue is present we must extend our denture beyond this ridge on the buccal so as to give a wider surface of bearing to stabilize our denture under biting strain. Hence, in these extreme cases of absorption we may have a denture that is very unstable on the ridge when the mouth is open, but resting on a solid base when under biting strain.

When we treat a lower ridge of good form Dr. Teuch's technic is very efficient as described in the Dental Digest, March Issue, but due to the various changes—laboratory technic, and the shrinkage of rubber during the vulcanization, a lower denture will rarely ever be as stable as the impression.

For this reason I prefer to waste little time on my lower impression and when the denture is completed I make a so-called refit which really means equalizing the bearing on the hard and soft tissues by properly compressing the soft tissues with compound.

This may have to be repeated at various intervals until the tissues are supporting the dentures uniformly and only then will that denture have its maximum efficiency.

After proper finishing of the rim and trimming of contour, correcting any little imperfections in the impression, the lower impression is complete and we proceed to our correctible upper impression.

As previously stated, we have displaced tissue with the rim of the upper impression. It is now necessary to produce a rim which is taken with proper facial movements in order to get an impression of the buccal muscles in their working position and with the mouth closed. The rim is cut away on one

side from the center to the region of the first molar and fresh compound is added. Glaze over the flame and temper in water at 160 degrees, place the impression tray into the mouth with the hard rim first and then turning the impression in the mouth, retracting the cheek on the heated side and seating perfectly into position. Have the patient close and bite and move the lips forward and back and exert a negative presure with the lips and cheek. With this action the buccal muscles cut down the rim so as to give these muscles free action and the negative pressure assists in holding the compound in proper position. Allow the compound to pass from the flowing state into the molding state, when you can bend it without changing form, and produce slight pressure at the rim in order to compress soft, flabby tissue which may overlie the base of muscle attachment. Proceed to the opposite side of the rim and treat it in a like manner. If there is considerable movable tissue at the posterior two-thirds of the vault, examine the extent of such soft tissue and with a compound tracing stick, trace compound on the palatal portion of the impression, varying in thickness to the amount of tissue you have to displace and compress. Also trace compound around the tuberosities and in the molar region glaze over the Bunsen flame, temper in hot water and quickly place the impression into the mouth seating it perfectly to the anterior ridge only but not having it come in contact at the heel. Have the patient close and bite the impression into position causing the compound to flow backward. This forces the tissues with it and changes the impression from that of one with a mouth open to one with the mouth closed.

Having preformed all steps properly your impression will now be ready for the test. This test should be perfect stability under the masticating stress, lateral tension, and any movements of the mouth that the patient may choose to make naturally. If there is a soft ridge in front the technic varies insofar as we must get an impression of that soft ridge in its normal position. To secure this the labial portion of the rim of the impression must be cut away and then the tray placed into the mouth and biting stress applied to note the amount of distortion of these tissues. The palatal portion, or the part in direct apposition posteriorally to this soft ridge is trimmed away sufficiently so that biting strain will not displace this tissue. The amount of displacement that we find in these cases is very often greater than we have any idea of, hence any scraping of an impression for subsequent refitting that is done without having full view of the case will usually fall far short of proper trimming, since the distance to which it is displaced is greater than we usually anticipate.

Having the tissues now hanging in their normal, proper position, we slightly heat the compound back of this soft ridge and add sufficient compound to the labial portion to form the rim, placing well forward so that we can glaze it in the Bunsen flame. Holding it in that position we place the tray in the mouth, have the patient close, and pack the compound against the labial portion of the soft ridge and have the patient give the face movements and producing negative pressure. This forces the soft rim against the hard compound back of it and gives us an impression of these tissues in their normal position. The length of the impression is then determined by adding about 1-32″—1-16″ of compound to the heel to give us proper stability for the incising act.

This produces an impression of both upper and lower jaws, which with proper anatomical articulation of teeth procures the utmost stability and comfort to the patient.

In taking the impression for a full upper case with natural teeth in the lower, the compound technic has a valuable advantage in producing a normal

and unstrained bite. The lower mandible is very easily distorted due to the flexibility of the temporo-mandibular articulation. There is nothing more disagreeable in wearing a denture than having a strained bite and I know of no technic which is as positive in producing an unstrained bite as the compound technic, even where plaster impression is taken. We all know to what extent the lower mandible will accommodate itself under various conditions. The teeth on one side of the jaw may be brought together, even tho several thicknesses of paper are placed between the teeth on the opposite side. You can produce more pressure on one side of the jaw than on the other at will. In the masticating process, if the teeth pass thru a harder substance on one side than on the other, the jaws will be farther separated on the side where they pass thru the greater bulk of material or of greater density, hence any material which cannot be brought into a state of producing the least possible resistance with a subsequent advantage of correcting faults, or of producing proper results is not indicated. This is very forcibly explained in getting the bite for a full upper impression, the technic of taking the snap impression being the same as for full upper and lower with the exception of forming the bite block. Judging the amount of material necessary to form the proper bite block you attach the compound roll to the bottom of the tray and carefully shape it to the proper outline of the lower teeth. Heat it thoroly in water at 160 degrees, place into the mouth and have the patient close the mouth until the lips touch. This gives you a bite block with the lower jaw in the rest position. Examine the bite block as to the side thru which the lower teeth passed thru the greatest amount of material, trim the occlusal surface until only the glossed parts of the tips of the teeth remain, and place into the patient's mouth and have him bite, and you will always find that when the patient bites together he will strike first on the side where the jaw passed thru the greatest amount of compound, producing a certain twist to the snap impression. This proves that you have a strained condition and a condition under which a great many dentures are worn. To correct this condition cut away enough compound on the strained side to the thickness of about a cardboard, re-heat the entire occlusal surface about 1-32 inch in depth, place into the mouth, have the patient close the lips and swallow once and hold firmly. The swallowing act brings the lower mandible from the rest position into the position of occlusion. Remove the impression when the bite block is thoroly cooled and you will invariably find that the teeth have passed thru an equal thickness of compound even tho you have cut away on the strained side the thickness of a cardboard. You now place the impression into the mouth for the test and if this step has been properly made you will have an unstrained bite. You have formed a bite block which represents proper length of teeth and a guide for placing the cast of the lower teeth in position.

A denture constructed after this technic with the teeth set up anatomically so as not to interfere with the lateral movement of the jaw will be worn with perfect comfort.

In constructing full upper and lower dentures according to compound technic for Classes 3 and 4, where you have established an unstrained bite, made the proper transfers to the articulator and maintained these conditions thruout the entire laboratory technic, full upper and lower dentures can be constructed with perfect, unstrained bite, eliminating any future mounting of the completed dentures on an articulator for grinding the occlusal surfaces.

I contend that the compound technic is rapidly solving our denture problems and if I have been able to arouse a

little more enthusiasm for modeling compound my efforts have not been in vain.

Discussion.

J. H. Hospers, Chicago

I have listened with great pleasure and attention to Dr. Brenner's paper and remarks. I can say that the method described is, in a general way, the one followed by me in my practice. However, I believe that much has been left for the imagination to supply. In the use of a material that has not received a prominent place and a thoro instruction in a dental course, naturally all explanations should be made in detail. Pardon me, therefore, if I should seemingly dissect the paper.

Of all operators, Dr. Brenner is "IT," when it comes to taking an impression a-la-compound. He however, has passed over a number of points that need particular emphasis. In his discussion of the classifications of jaws, he mentions the jaw that has been deformed, so to speak, by a lack of occlusal contact in the molar and bicuspid region when only the lower anteriors are in place and an upper denture is worn. This is a fault of the operator and the patient should not be blamed for the fact that they have no posterior teeth as they may never have been informed of the bad results of their absence. Lack of information and a mistaken idea that lower dentures are never satisfactory are the primary causes for this condition. I hope you will not take amiss a few remarks on my idea of this method.

Every dentist has known of the difficulties to be overcome, but few have had the courage or the desire or the ability to go thru the long series of experiences necessary to find a better way. Lately, however, much work has been done to accomplish this end and today we begin to see the solution of this very vexing problem. In fact, it seems to be no unreasonable prediction to say that very few edentulous mouths are now impossible to fit with satisfactory dentures. Yes, satisfactory and efficient both from the standpoint of the patient and that of the operator. For undoubtedly, a snugly fitting denture means a satisfied patient and a satisfied patient is an asset to your business. The reverse is equally true. No one can do more to injure your reputation then a patient with an ill-fitting denture. If then the methods of taking impressions as described by Dr. Brenner, and again described by me seem to you to be longer and more arduous than the one you now employ, remember that the finished denture is the objective you have in view and not alone the fee you are to receive for the service rendered.

This paper, however, cannot go into a complete history of denture making and impression taking. Suffice it to say, that present methods of impression taking have resulted in the use of two materials, plaster and modeling compound. By far the greater number are strong and ardent supporters of plaster when used for this purpose. Their stand is taken because of the prejudice displayed against modeling compound by their teachers and professors while at school and also because of the effort they think is required to learn the use of this material. However, I cannot help drawing comparisons and therefore quote the following from Dr. Prothero's book on Prosthetic Dentistry, page 81. (Note as I quote, how he contradicts himself). "When manipulated properly in well selected cases, modeling compound is a most reliable impression material. In probably seventy per cent of the edentulous cases presenting, compound can be used to a better advantage than plaster."

Page 60 he says, "The value of plaster as an impression material lies in the fact that it can be readily adapted to the most irregular surfaces and carried into deep undercuts and embrasures, from which it can be removed by fracturing and the broken parts readjusted with ease." He suggests the following

places for the use of plaster. First, in all cases where any of the natural teeth are present. Second, in case undercuts exist, either on the opposite surfaces of the borders, or in spaces formed as results of natural teeth. Third. Where flabby ridges are present. Fourth. In edentulous cases where the mucous and sub-mucous tissues are thick and elastic, particularly in the palatine portion of the mouth. When such a condition prevails, (remember I am still quoting) the tissues, if compressed uniformly as when modeling compound is used, assert their resiliency on pressure being relieved, which breaks the peripheral adaptation of the impression, and later on of the denture that may be constructed when such impression is used as a basis." Please note that this is one of the things we do get in the use of compound, viz., equalization of pressure on hard and soft tissues. Dr. Prothero says further, page 84, "When the layer of softened compound is of uniform thickness and is sufficiently plastic, under continued pressure the material gradually flows from the hard to the soft areas, compressing the latter and relieving the pressure on the former, until a sort of equilibrium is established. Thus Dr. Prothero contradicts himself in his book.

We are happy to say there is not a single instance in which modeling compound cannot be used to advantage and in cases of soft ridges and flabby tissue it becomes the material par excellence. You advocates of plaster cannot deny that the only reason you do not use compound is because you do not want to try.

With this lengthy introduction let us take up the subject of discussion. One important thing in the making of a denture, is its sale, and this cannot be accomplished unless a number of seemingly unimportant details are taken note of. I will just mention a few. Dentists should be well groomed, tie shirt, collar and coat clean. Hands and finger nails clean. Office dusted and cuspidors cleaned. No direct light in patient's eyes. Use rubber apron and collar and clean towels. Have models for demonstration. Show yourself master of the situation. Confidence begets confidence. Then state your fee. Examine the mouth for muscular attachments whether high or low, soft or hard ridge, uniform, dense or spongy tissue and then classify and determine the steps to be followed. I use the same classification as Dr. Brenner, apparatus to be used consists of Supplee outfit. (Hot and cold water pans, heater, thermometer, spatula, gas or alcohol lamp), and a jeweler's blow pipe. Connect to circuit and turn on current. Drop three cakes of Detroit compound into the water if a full case. Select a tray to fit case as nearly as possible and trim and bend so that the posterior margin fits against the tissue when inserted into the mouth. Trim to have tray clear muscular attachments by one-eighth inch all around. Determine the length of the plate by locating the vibrating line. This is a line formed by the union of the compressible soft tissue with vibrating tissue in the rear of the mouth. Mark with a pencil. (Indelible). Your tray should extend to this line and never beyond it.

The tightly pressing tray in this region will prevent gagging and the worst case of this kind can be fitted to dentures without any inconveniences to the patient.

Remove a small piece of compound about the size of a walnut, from the heater with the spatula. Moisten the hands to prevent the compound from sticking to them. Roll compound into a ball and hold over flame until it sizzles. Then apply to palatal surface of tray and mould into a rough form of an impression. Hold over the flame to soften thoroly, dip into the hot water, in order to equalize the heat and pass into the mouth sideways, center and bring to position with a wave-like motion pressing upwards and forward. Dr. Brenner ways backward. This gentle pressure, about the same as when setting a P. V.

crown, gradually works the softened compound between and over the rugae and allows them to find their proper position without any undue pressure on any elevated parts. With the index finger of the free hand lift up the lip and flip up the compound on both sides, under lips, and massage, being careful to hold the tray steady and with an even pressure. Have patient give motion to the lips and cheeks and massage gently in the region of the tray to force surplus material to flow down towards ridge. Hold until cold about three and a half to four minutes. Care must be used not to shift the pressure after it has once been established, in order not to cause a shift or second movement in the hardening compound. Such a movement would cause a faulty impression and especially in this first step is it absolutely necessary to hold steady. It seems to me that this may be the cause of many failures of impressions taken in modeling compound, viz., the shifting of pressure in the initial or base impression, it being very difficult to keep up a steady pressure for three or four minutes. Stand before the patient and placing your elbow upon your hip to steady and hold the tray in position. Have your assistant cool the compound either with compressed air or water, if you wish to hasten it's setting. If this step has been properly performed we have secured the base or snap impression which acts as a key to the completed operation, in that it always remains hard and guides the impression to its proper position every time more material is added. We should now have a good impression of the roof of the mouth and of the rim as far back as the ten fronts. If any portion of the tray is exposed, bend it back with plyers or cut it away with a stone or bur and add sufficient material to fill, flush and re-take. Do not let the tray show thru as it indicates hard pressure on the underlying tissues and will mean sore or hot spots in the completed denture. This can be easily demonstrated by cutting away the compound to the tray at the exposed part, then insert the impression into the mouth and the blanched condition of the membrane overlying the spot indicates the truth of the assertion, that this same condition would exist in the completed denture. This is probably one cause for the soft spots so often formed in the jaw under a plate and mentioned by Dr. Brenner in his paper. The impression should now stand a test in the bicuspid region.

Before completing the upper impression, however, a true bite is absolutely necessary. A biting block must be formed to establish the occlusal plane by means of which the lower impression is completed, thus automatically establishing a non-muscle strained bite. Draw a line on the face from the meatus of the ear to the ala of the nose and another line parallel to this from the angle of the mouth. Dry the back of the tray and apply a roll of soft compound and insert into the mouth and place the occlusal plane former against the compound, the handle acting as a continuation of the lower line drawn on the face and parallel to an imaginary line drawn thru the pupils of the eyes, when the patient is looking directly at you. (The occlusal plane former is a flat spatula shaped piece of aluminum which is placed in cold water before applying.) Cool and trim new compound to a narrow ridge. Cool in ice water. Place the impression in the mouth and test for action or interference from the coronoid process of the lower jaw. Remove all of the biting block from the heel of the tray as far forward as the first molar and then proceed with the lower.

The essentials of the lower impressions, are, A—The impression for the outer rim from first molar to first molar with the mouth open. The same position assumed by the muscles as when they contract during swallowing. B—Molar regions with the mouth closed and under pressure. C—The inner rim with

the mouth closed and patient swallowing and also lifting and moving the tongue sideways and around in order to relieve undue pressure of the compound on the mylo-hyoid muscle.

For the lower we use the occlusal plane tray. This tray is nothing but a flat tray and its convenience is its chief merit. It should not be too long and should spread sufficiently in the molar regions to clear the tongue. With it we obtain an accurate bite and a base impression of the lower ridge in one operation. Great care must be taken at this point, not to inform the patient what we are going to do. Never tell the patient we are going to take a bite. It will complicate matters, as the patient will always protrude the lower jaw as if incising and this is certain to give a wrong result. Proceed as follows: now Mrs. Jones, I intend to get the normal relation of the upper to the lower jaw. I am very anxious to get this right as it will save us a great deal of time and make a far more satisfactory denture. Now watch me and do just as I tell you. Put your tongue as far back as possible to the roof of your mouth, close the lips, and then swallow just once. Have her do this once or twice and without any further instruction prepare for your impression. Place a roll of compound on the tray, sufficiently large to fill the space between the upper occlusal plane or bite block and the lower ridge, the upper impression being in place, and if no real suction has been obtained in the base impression of the upper, a little correga can be used to a great advantage during this step and while completing the lower. Cool the tray side after applying the compound and suspend the compound in hot water moulding to an approximate form of an impression of the ridge. Re-heat the compound over the flame, bringing to a gloss, and dipping it quickly into the hot water in order to equalize the heat, pass it into the mouth, placing it a little forward, instructing the patient to close the lips, which pushes the tray and compound back. (In other words, centers it) and place the tongue to the vault of the mouth and swallow once, maintaining this position of the jaw until the compound has set. This has forced the occlusal plane tray against the upper biting block, established the correct bite and given us the impression of the lower ridge and rim in the region of the ten fronts. Test this by having the patient snap the impressions together. If you hear a solid snap as in the sharp closure of a normal mouth, the result is correct. If, however, it does not strike uniformly, a little compound should be added on top of the tray on the side where the second click is heard. It becomes necessary to be extremely urgent in demanding that the patient swallow but once at this time. The act of swallowing is a complex operation. The lips are first closed, bringing the jaws back into position and also locating and centering the impression. Then the jaw is closed to its proper closed position. A second swallow has a similar action except that the lips are already closed and the jaw is also in opposition with the upper. Therefore, we get a more determined bite and closing action, forcing the jaw thru the soft compound and registering an inaccurate bite. In an edentulous case the lower jaw is thrown upward and forward. Test and if wrong correct at once.

Proceed with the lower impression. Cut away well on the molar region on both sides, rewarm and add fresh material, using mouth blow pipe to fuse union between new and old material. Pass into mouth, seat impression in region of ten fronts and have patient close, swallow several times and give face movements. The lower should now stand the same test as the completed denture. Test and check for leaks and impingement on muscles. Trim away compound to allow free action of all muscular attachments always leaving beveled edges. Re-rim entire impression

with the green tracing stick holding impression in position and compressing cheeks with thumb and forefinger of the right hand. Apply green compound in region of phrenum linguals and place in mouth, having patient stick out tongue to insure free action. Test again for stability and then proceed to complete upper. Freshen edge and trace green compound to complete the margin of the rim in region of ten fronts, insert and have patient close and give lip and face movements, keeping the mouth tightly closed and the two impressions in contact. Massage over the margins and pull towel tight over lip to keep firmly compressed. Cut away in region of tuberosities, bend down tray at heel and add fresh material, placing in mouth and telling patient to close, suck and give face movements. Sucking presses the tongue up against the palate, closing the heel of the impression and pushes the compound against the tuberosity and causes the masseter muscle to compress it from the buccal side, trimming it for muscle strain. This last step changes the impression from an open to a closed mouth impression that should stand the same tests as the finished denture. Use the green stick to complete rim. Test it by letting the patient bite on a tracing stick or a pencil, in the molar, bicuspid, and incisor regions. If it stands the test, mark center, high and low lip lines and angles. Lay on a piece of compound to act as a guide for mounting the models on the articulator, cool and prepare impressions for pouring.

A few words of caution may be advisable at this point. Be sure that no particles of hard compound remain in impression at any time before inserting into the mouth. One small piece may distort the adaptation. Another point to watch is the wrinkles and overlaps when new compound is added. Always remove them and remove all traces of union by heating with mouth blow-pipe and reinserting into mouth. Altho this will now test for every purpose, the finished denture will have a tendency to settle and so ride on the high and hard spots. Locate these in the mouth, outline with an indelible pencil and dry impression and place in mouth, causing slight twist, thus transfering mark to impression. Scrape for relief, using a Kingsley finisher, amount depending on area in mouth. No suction or air chambers should be used as they soon become filled with a sort of scar tissue, which makes an easy fulcrum for tipping the plate. Use too little material, rather than too much. Do not immerse the tray into hot water as it retains the heat, transmitting it to your first impression, distorting and spoiling it. Another cause for failure. Always cool thoroly before removing. Compound flows from the base to the crest of the ridge, compressing and equalizing the pressure on all tissues. A plate made from an impression of this kind rides the jaw much the same as a load on the back of a burrow. It is not placed on top, that would make him top-heavy, but down on the side, compressing the sides and hanging from the back, thus holding steady and secure. Remove particles of compound from trays, when it sticks, with acetone and the trays will always be clean.

Hot dry compound sticks to any dry surface, but not to a wet one. Always dip into hot water before inserting into the mouth after heating. Cores can be formed of any undercuts and more beautiful and accurate results can be obtained than from plaster. Prepare the impression for pouring by drying carefully with compressed air, filling in all cracks with base plate wax, cooling thoroly before removing surplus. Mold a rim of plasticine about a quarter of an inch wide around the entire periphery of the impression, about a quarter of an inch from the border, then varnish impression with sandarac varnish. Dry and pour at once in Weinstein stone. If not poured at once, keep in water

until ready to do so as a change in temperature will affect the compound.

How many men systematize an impression? How many really know what they are trying to get? This, gentlemen, is a service composed of many intricate steps and each one depends upon the previous step. It's final results should be an artistic esthetic and effective piece of dental replacement. No small fee can repay you for the work you should do.

A jeweler once asked me why a certain piece of work cost so much and I replied. "If you had to make a new set of dies and models for every watch you sold, it would cost you at least $200.00 to turn out a watch." He saw the point and paid the bill. I hope that this little talk on professional denture service, will lead you into green pastures of ease and comfort. Above all, don't give up. If I have used an argumentative tone in this paper, pardon me, for I am sure whereof I speak. We, who use compound, do not fear, but rather invite criticism, for the cold shoulder we once received, has long since frozen the thin ice we at first had to cross in order to get to our present determined stand on the use of compound.

First, it is the least objectionable.

Second, the impression can be put thru the same test that the plate will have to undergo.

Third, muscle trimmed. Hence no sore mouth from sharp edges on plate.

Fourth, equalization of pressure on hard and soft tissues.

Fifth, bite and impression completed at the same time.

Sixth, use of a sterilized material.

Its only objectionable feature is that more time is consumed to get the desired results, but this loss of time is fully compensated for by the fact that no adjustments are necessary afterwards.

Every operation or service you render, requires a careful painstaking effort to make it permanent. The only difference is that a poor root filling, a poor amalgam filling, a poorly fitting crown or inlay, all stick, and the *poor* patient does not get wise. The dentist gets away with it, but when it comes to a poorly fitting denture, all the art of dentistry cannot deceive the patient. Suctions or air chambers or correga or what not.

So, gentlemen, thank God for modeling compound, for a nicer, cleaner, pleasanter, and more certain impression material cannot be found.

V. P. Perisho, Streator.

I want to congratulate the essayist on this most excellent paper. He has given us a technic that we should master if we ever expect to acquire success in the construction of artificial dentures.

After classifying the jaws, the essayist describes his technic in securing the impressions for classes 3 and 4 jaws. I have been fully convinced that we would have fewer classes 3 and 4 jaws if we would follow the method suggested by Dr. Carl Lucas of Indianapolis. Dr. Lucas advises extracting, curetting the sockets, relieving all undercuts and stitching the gums under perfect surgical asepsis mouths will heal at once prepared in this way and the impression can be taken much sooner. I have taken the impression in 12 to 14 days after extracting, with most satisfactory results. Very little absorbtion of the process takes place after this surgical treatment.

I said in the beginning that we should master the technic as advocated by Dr. Brenner. Without knowing the classification of mouths and without the vivid mental picture of what this impression should look like, we cannot expect success. We must know for what we are striving. Dr. Brenner speaks of the perfectible impression and the way to get a perfect impression. I consider this a very good beginning. When he has finished, I still think that his impression is a perfectible one.

It has been said that we have a mold-

er's job when we attempt to get an impression which will produce a cost that is a perfect reproduction of the jaw to be covered by the denture. In my estimation plaster of Paris properly mixed, is the most yielding material that we have. It has no rival when we want a perfect mold.

It is almost impossible to get a perfect impression with modeling compound, because the compound will not flow to place, but must be pressed to place and thus will displace soft tissue, therefore it should be used for the tray. If this tray is properly trimmed we can get a perfect impression by using a creamy plaster, properly mixed, because thin plaster will conform to tissue without being forced to place as you are required to do in handling the modeling compound. By the use of plaster we do not need the so called closed mouth impressions.

Dr. Rupert E. Hall described his technic in a paper that was read at our Annual meeting last year and a full report is given in our 1918 transactions. Dr. M. M. House, of Indianapolis, gave his technic in full in a paper read before the National Association at Chicago last August and it is printed in the National Journal of December 1918. I am a convert of these men and I have found their technic far superior in my hands to any other.

I want to say a few words regarding the impressions in soft ridge cases. I will speak of the upper. Secure the compound impression as Dr. Brenner described. (I use the S. S. White Impression Tray Compound in place of modeling compound.) See that you have your muscle trimmed, peripheral seal and a perfect outline of the impression, as you want your finished denture. Take a small bur and puncture this compound tray in several places at the lowest labial point, then scrape your tray or impression so this soft ridge can hang perfectly free without the slightest pressure on it. Then use warm water to which has been added some potassium sulphate, sift Kerr's Snow White Plaster and mix by thoroly stirring until it is of the consistency of cream. Add this to your compound tray and work it up to place with an oscillating movement. This soft plaster will work out thru the perforations without producing any pressure on the soft ridge.

This impression should be post dammed, by adding Kerr's tracing stick compound to the posterior palatine surface. This may be placed over the plaster or you may scrape the plaster off at the posterior edge and warm over Bunsen, then add your compound. Dip in warm water and work it to place. This will give you an impression with a perfect seal and one that I know from experience will give the desired results.

Victor H. Sears, Chicago.

It is an encouraging sign when the modeling compound advocates and the plaster wash advocates begin to publicly proclaim virtue for both methods. The time seems near at hand when all prominent prosthodontists will be proficient in both the modeling compound and plaster methods of taking impressions.

One feature of the essayist's paper which distinguishes it from some other papers recently given on the same subject is that it does not attempt to discredit any system or method of preparation other than the essayist's choice altho it is made quite clear that the modeling compound technic is indicated in certain types of cases.

Under the head of examination there might be mentioned one other factor which may be of importance before starting to take the impression; that is the amount of space between the tuberosity of the upper ridge and the ramus. If the space here is too small the impression may not extend fully over the tuberosity unless we first resort to surgical measures.

Regarding the important point of examining the mouth at intervals while

the dentures are being worn, Dr. Brenner says that this makes the patients "realize that you are interested in their welfare". This is true and it has the further advantage that we may know whether our patients are wearing the dentures we make for them or whether they are wearing the other dentist's plates.

The "rest cure", as described in the paper, is probably new to most of us and appears to be a very practical suggestion, especially when a metal base is to be made in place of vulcanite.

There is one more important point mentioned in the paper which can hardly be too much emphasized at this time; that is that a denture which sticks and is comfortable is not necessarily successful. It may stick in place and still spoil the supporting value of the jaw for future dentures. This is particularly true of dentures made soon after extraction and of dentures which are only partially antagonized by teeth of the opposing jaw.

If faulty denture construction is responsible for changing a class 1 or 2 mouth into a class 3 or 4 mouth the dentist and his patient may suspect that the dentist is losing his skill as a prosthodontist when he later attempts to fit the same mouth by the same methods. If the dentist is a better talker than he is a prosthodontist the patient may be made to believe that the workings of nature have made it impossible for man to overcome the obstacles but after listening to the able paper of this evening it will be much more difficult for an honest operator to explain the mistakes of nature.

Raymond R. Blanchard, Springfield.

Owing to the fact that I gave a clinic last year to which you gentlemen so kindly gave attention on plaster impression technic, let me say a word or two right here. We must understand the forces that we are undertaking to control when we take an impression, and when we apply a denture. What is there pulling down on the denture that may displace it? Gravity alone. What is necessary to overcome gravity? Adhesion and cohesion, but when the patient starts chewing, adhesion and cohesion are not strong enough to overcome that force, and we must bring into play atmospheric pressure. That is the reason we have to examine these mouths, and that is the reason we have to decide on what we are going to do after taking an impression of the mouth.

The essayist made two statements, one of which concerned a rule which I follow, that you must take an impression under equalized pressure. Later on in the paper he gave the advantage of the compound, saying that it would compress and displace tissue favorably. If we compress and displace tissue, we have not equalized pressure because we are compressing the tissues and in displacing them the pressure is unequal. What I maintain is that we must take an impression of the mouth under equalized pressure without distortion, for when you distort tissue or displace it, at the end of six months that tissue has assumed the position in which you displaced it. You have not quite gotten the results there that you would have obtained if you had not displaced the tissue, because the tissue has had to stretch or assume an abnormal position, but you never get the normal back again; once you displace tissue it is displaced forever. When I use modeling compound in displacing tissue in an impression, at the end of six months patients come back. The tissues have assumed the position in which I had displaced them, and they have presented a reddened appearance, they were not normal, and they did not retain their resiliency at the end of six months.

We must take an impression of the mouth with the tissues in a normal

position, not displaced, so that at the end of six months the plate will have the same suction and chance to pull as it did when we took the impression.

Dr. Brenner (closing the discussion): I am certainly gratified at the discussion of my paper as it brought out some lively arguments. I said a thing was white and somebody else said it was black. We must expect a diversity of opinion in discussing papers. We may take two directly opposite extremes in order to get down to a happy medium.

I wish to speak briefly about the surgical treatment which Dr. Perisho has so ably presented to you. It is treatment that I always advise, and instruct my exodontists to do it in every case of extraction. You can take an impression as soon as the swelling has gone down. Don't try compound, take plaster. I believe I take more plaster impressions than compound impressions, for I find the greatest amount of work referred to me consists of new cases where dentists look at the jaw and the teeth have been extracted on one side, and the teeth on the other side are not in good condition, including the bony structure, and they are afraid to undertake work for such cases and send them to me. In that way I get easy cases to handle, and I make these impressions with plaster with elegant results, but you do not get the impression that you will with modeling compound. You can take the easiest road with plaster and get good results. You must differentiate in your diagnosis of these cases, and use plaster where plaster is indicated and compound where compound is indicated. To the plaster men I would say, I hope you will be broad enough to take the pains and develop the compound technic.

I have taken several bridge impressions. I have taken impressions in every way and lots of them by the plaster technic. I can follow any technic you want me to and construct a perfect denture, but some of the basic principles can only be carried out with compound or with both. You can get with compound everything you can get with plaster. Please do not decry the technic because you cannot master it and attribute your failure to the technic. You are conveying a wrong impression to those to whom I am speaking. For the sake of the furtherance of technic, let us be open-minded and not ride a hobby. I do not hesitate to use any technic if I can get better results by it.

THE JOURNAL
of the
NATIONAL DENTAL
ASSOCIATION

Entered as second-class matter, March 22, 1915, at the Post Office at Huntington, Indiana, under the Act of August 24, 1912. Published Monthly.

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SUBSCRIPTION included in the annual membership dues.
SUBSCRIPTION, $2.00 a year, in advance, to non-members, living in all parts of the United States or its possessions. Canada, $2.50. Foreign countries, $3.00. Single copies, 20 cents.
ADVERTISEMENTS accepted only from reliable firms. Fraudulent and misleading advertisements barred.
IN CHANGES OF ADDRESS both the old and new address must be given.
JOURNALS are not sent beyond the subscription period.
ORIGINAL ARTICLES, items of news and matter of interest to the profession are welcome. Request for reprints should be made at the time of forwarding articles.

VOL. 6 NOVEMBER, 1919 No. 11

Editorial Department.

EFFECTS OF SCORBUTIC DIET ON THE TEETH OF GUINEA PIGS.[1]

In the Proceedings of the Royal Biological Society of London, the issue of May 15, 1919, occurs the report of experiments made by Doctors Zilva and Wells on guinea pigs by variation of diet. They report interesting changes on the teeth and their supporting tissues as results of this treatment. In 1917 Holst and Fröhlich showed that pathological changes analogous to scurvy in human subjects could be induced in

[1] Proceedings of the Royal Biological Society of London B. 90; 505, 1909.

guinea pigs by dietetic means, which findings the first named workers confirm. In proof of the diagnosis it was shown that the progress of the disease could be stopped and the animals restored to health by changing to normal food.

Macroscopic changes meeting all the requirements of scurvy appeared in advanced cases. To quote: "Teeth were sound but useless because of absorptions of the cement (peridental) membrane of the alveolar sockets. These teeth presented in addition all the appearances of senility."

Microscopic studies revealed pulpal changes interesting and suggestive as well as lesions in the calcified tissue. "The present instance affords an opportunity of examining certain structural metamorphoses of the pulp which are believed not to be dependent on any inflammatory condition but simply attendant on or produced by altered metabolism due to diet. It is evident that in complete pulpar fibrosis no cellular elements of any description occur. It is clear at once and it is an important fact that no trace of cellular organization, no trace of nuclei, no trace of interstitial cement substance can be found anywhere. Nerves, cells, blood-vessels and odontoblasts have all shared the process of fibrication."

An animal taken at birth and put on scorbutic diet showed symptoms of scurvy in two weeks and was kept in a chronic state for two months. It was then put on normal diet. Eleven days after, owing to the brittle condition of the teeth a lower incisor broke. This was found to be in a "highly deteriorated" condition histologically. After the animal had recovered weight and health its teeth were examined and showed two zones coinciding with the two periods of nutrition.

To quote verbatim: "We have convinced ourselves that the mildest degree of scurvy which could be discovered at post-mortem examinations produced well defined changes in the structure of the teeth." Two observations are emphasized. "In the first place it becomes plain that the tooth is one of the first if not the first part of the system to be affected by the deficiency of antiscorbutic material in diet. The second point to be marked is that when scorbutic symptoms during life are so slight as to be almost unrecognizable, profound changes in the teeth are recorded. The scorbutic changes of the teeth disclosed by the post-mortem examinations were such as could hardly have produced any discomfort to the animals yet the changes in the teeth were profound." Hess[2] in 1917 showed that children may suffer from subacute scurvy by no means easily recognized. He further defines another type which he calls "latent scurvy" which is a state of malnutrition that can be diag-

[2] Journal of the American Medical Association, 1917.

nosed only by an improvement in the state after an administration of antiscorbutics."

The work recorded by Doctors Zilva and Wells is scarcely more than suggestive. It awaits an investigator interested in dentistry for its own sake to carry the work further. The choice of guinea pigs for the research was fortunate in that their continuously growing teeth well represent human teeth during the developmental period. The findings suggest that various lesions of the hard tissues of the teeth may mark the absence of some vitamine in the nutrition. From the report it is apparent too that the calcified parts of the teeth may be affected and the pulp remain unchanged. The pulpal changes may take place apparently in adult teeth producing a tooth without normal pulpal elements. Would such a tooth robbed of its odontoblastic fibrillation resemble a pulpless tooth? And what of the possibility of the complete calcification of the fibrotic mass? Elsewhere this frequently occurs. In association with faulty calcification we think of such a tooth subjected to a susceptibility to caries. And what is the formative history of the tooth of a rachitic subject when the vitamines that stimulate general calcification are absent? Force is lent to the facts enumerated by the statement of the investigators that they failed to find a single exception to the effects stated of a scorbutic diet.

WHY GAMBLE WITH YOUR SAVINGS WHEN THE GOVERNMENT OFFERS IDEAL INVESTMENTS.

Upon no class has the burden of the high prices of necessities fallen heavier than on the professional men and women of America. Their incomes from professional services have not increased in the proportion to the stimulus given other lines of endeavor. Their rewards of labor have not been augmented, yet the purchasing power of their incomes has been diminished by more than fifty per cent.

Bound voluntarily by the ethics of honorable professions, they have been unable to meet the profiteer on his own ground. They cannot fight fire with fire.

Yet they and the other citizens of America are not weaponless against the high cost of living. They have a sovereign remedy in their own hands, a remedy which it is their duty to themselves and to the nation to prescribe and to take in doses as large as can be absorbed by each individual and domestic body. That remedy is thrift.

There are two ways of increasing the profits of any business, professional or otherwise, increased receipts or reduced costs. Careful buy-

ing, elimination of waste, curbing of extravagance, regular and consistent saving and safe and conservative investment will increase the profits of the professional man no less surely than an increase of income.

Following the close of the war America fell into a perfect orgy of extravagant buying, without regard to price.

The decision "I'll take it," ceased to be preceded by the query "How much is it?" Entertainment was carried on on a scale that smothered hospitality under tawdry ostentation and that ostentation spread itself thruout the life of the nation until the comforts of life ceased to be distinguished from its non-essentials.

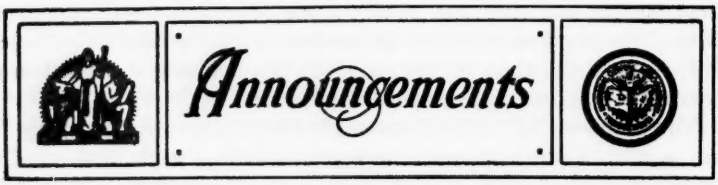
This spendthrift enthusiasm does not indicate a weakening of the fiber of the country. It merely arises from a natural desire to enjoy some diversion after years torn by anxiety and conflict. But those who practice it, forget to ask their cost or the cost of others, that diversion may be enjoyed without vulgar extravagance. Moreover they played directly into the hands of the profiteers.

No merchant can profiteer if customers refuse to pay his profiteering prices. Intelligent economy and consistent saving by the citizens of the United States, not only will bring individual relief from prices but it will enable the nation to meet successfully a crisis no less sinister and pregnant of peril than any encountered during the war.

Our government thru the Savings Division of the Treasury Department has provided the mechanical means for such saving and investment in War Savings Stamps, Thrift Stamps, Treasury Savings Certificates and Liberty Bonds. These securities, safe, sure and profitable are adapted to the saving and investment of any sum, no matter how large or small.

Why should members of our profession gamble with their savings by investing them in all kinds of "get rich quick schemes" when our Government offers us such a variety of ideal investments?

If a dentist during the productive period of his life would carefully invest his savings in legitimate enterprises and Government securities, he would not be a financial burden to his family, friends, state, or a candidate for financial assistance from the Relief Fund when his eyes become dim and his hand is palsied.



STATE SOCIETIES.

December.

2-3-4—Ohio.

NORTH CAROLINA STATE BOARD OF DENTAL EXAMINERS.

The next meeting of the North Carolina State Board of Dental Examiners will be held at Charlotte, N. C., beginning promptly at 9:00 o'clock on Thursday, January 15th, 1920.

For further information and application blanks, address

F. L. HUNT, Sec'y,
Asheville, N. C.

BRONX COUNTY DENTAL SOCIETY.

Dental education meeting with post-graduate clinic courses and manufacturers' exhibits, Hotel Commodore, December 2, 3, 4 and 5. Indorsed by First and Second District Dental Societies. Essays by some of the most prominent men in the profession who will tell us something that will be of help to the general practitioner. Progressive post-graduate clinic courses will be given by the Detroit Dental Clinic Club. The reputation of this body of men for their fineness of technic and their ability to demonstrate and teach their methods is such that no one should miss this opportunity. Courses will be limited as to number and as to number who can take them. Full information will be forwarded later. The grand ball room will be given over to the manufacturers' exhibit, which will be one of the largest ever held in this city.

Sincerely yours,
BRONX COUNTY DENTAL SOCIETY.
Dr. Frank E. Buckley, President,
2503 Marion Ave.

SOUTH DAKOTA STATE BOARD OF DENTAL EXAMINERS.

The next meeting of the South Dakota State Board of Dental Examiners will be held in Sioux Falls, South Dakota, January 7th, 8th and 9th, 1920, beginning promptly at 9:00 A. M. January 7th.

All applications must be in the hands of the Secretary by January 1st. Fee for examination $25.00. No reciprocity or interchange. Full information and application blanks may be received by addressing

L. S. Spencer, Secy.,
Watertown, South Dakota.

THE CONNECTICUT STATE DENTAL COMMISSION.

The Dental Commissioners of Connecticut will meet at Hartford, November 20th, 21st and 22nd, 1919, to examine applicants for license to practice dentistry, to examine applicants for dental hygienist's license and to transact any other business proper to come before said commission.

For further information, address

EDWARD EBERLE, Recorder,
902 Main St., Hartford, Conn.

BOARD OF DENTAL EXAMINERS OF CALIFORNIA.

"The next meeting of the Board of Dental Examiners of California for the purpose of examining applicants for a license to practice dentistry in this state will be held in the City of San Francisco, beginning on the 6th day of December, 1919, at 9:30 A. M. Each applicant shall file with the secretary of the Board at least ten days before that date the following credentials: (1) diploma or certificate of graduation from a reputable dental college approved by the Board; (2) a diploma from an accredited high school or a certificate signed by the State Superintendent of Public Instruction (or similar officer) to the effect that the applicant has had scholastic preparation equivalent in all respects to that demanded for graduation from a high school giving a four year course of instruction. An applicant who has been a licensed practitioner of dentistry of some other state of the United States for a period of at least five years, shall file such license or licenses which will be accepted in lieu of high school credentials; (3) testimonial of good moral character; (4) a recent unmounted photograph of the applicant."

"For further information address the secretary,

C. A. HERRICK, D. D. S., Secretary
133 Geary Street, San Francisco.

OFFICIAL SCHEDULE

Of Michigan State Dental Examination, Session, Beginning Monday, Nov. 17, 1919, at 8 A. M. at the Dental College, Ann Arbor, Mich.

Monday, Nov. 17—8 A. M., Physiology, J. C. Arnold; 10 A. M., Histology, A. P. Whittemore; 1 P. M., Bacteriology, J. B. Roe; 3 p. m., Chemistry, B. S. Sutherland.

Tuesday, Nov. 18—8 A. M., Materia Medica and Therapeutics, J. B. Roe; 10 A. M., Oral Surgery, E. O. Gillespie; 1 P. M., Anatomy, A. P. Whittemore; 3 P. M., Orthodontia, J. B. Roe.

Wednesday, Nov. 19—8 A. M., Pathology, E. O. Gillespie; 10 A. M., Prosthetic Dentistry, J. C. Arnold; 1. P. M., Operative Dentistry and Hygiene, B. S. Sutherland.

Thursday, Nov. 20—8 to 12 A. M., Crown Work, B. S. Sutherland, assisted by Gillespie and Arnold; 1 to 5 P. M., Plate Work, J. C. Arnold, assisted by Whittemore and Roe.

Friday, Nov. 21—8 to 12 A. M., Crown Work, B. S. Sutherland, assisted by Gillespie and Whittemore; 1 to 5 P. M., Operating, E. O. Gillespie, A. P. Whittemore, assisted by others of the board.

Saturday, Nov. 22—8 to 10 A. M., Plate Work, J. C. Arnold, assisted by Whittemore and Sutherland.

Note—All practical work should be completed and marked by Friday evening.

B. S. SUTHERLAND, Secy-Treas.,
Owosso, Mich.

MARYLAND BOARD OF DENTAL EXAMINERS.

The Maryland Board of Dental Examiners will meet for examination of candidates for certificates in Baltimore on November 19 and 20, 1919.

For application blanks or further information apply to

F. F. DREW, Secretary,
701 N. Howard St., Baltimore, Md.

INDIANA STATE BOARD OF DENTAL EXAMINERS.

The Indiana State Board of Dental Examiners will hold the next examination at the State House, in Indianapolis, November 17th to 22nd, inclusive.

For instructions and applications, write to H. C. McKittrick, Secretary, Indianapolis.

MARQUETTE UNIVERSITY DENTAL ALUMNI ASSOCIATION.

The Marquette University Dental Alumni Association will hold its meeting February 11, 12, 13, 1920 in the Milwaukee Auditorium, Milwaukee, Wisconsin.

V. A. Smith, Secy.,
755 Second St., Milwaukee, Wis.

STATE OF NEBRASKA, DEPARTMENT OF WELFARE.

The Nebraska State Board of Dental Examiners will hold a regular examination at the Capitol and the Nebraska College of Dentistry, November 17,18, 19 and 20. For applications and information, address: Secretary Department of Public Welfare.

H. H. ANTLES, Secretary,

DENTAL CORPS ORDERS FROM WAR DEPARTMENT.

DENTAL CORPS.

Col. Frank P. Stone to Fort Logan, Colo., for duty.

Lieut. Col. William S. Rice to Washington for duty in attending surgeon's office.

Lieut. Col. Lester C. Ogg to Columbus Barracks, Ohio, for duty.

Capt. Arthur T. Burchill to Millington, Tenn., air service flying school, Park Field, for duty.

Capt. William S. Shuttleworth to Jefferson Barracks, Mo., for duty.

Resignation by Capt. Norman M. MacKenzie accepted.

First Lieut. George B. Curtis from Philippine Department to San Francisco and report to commanding general Western Department for duty.

First Lieut. George B. Curtis at San Francisco, Calif., report to commanding general Western Department for duty.

First Lieut. James S. Dailey to Camp Normoyle, Tex., for duty.

The following to duty at hospitals: Col. S. David Boak, Walter Reed General Hospital, D. C.; Maj. James B. Harrington, Fox Hills, N. Y., general hospital 41; Capt. James J. Weeks, Fort Sheridan, Ill., general hospital 28; Capts. James B. Mann and George A. Cloutier, Jr., Fort McHenry, Md., general hospital 2.

—*Army and Navy Register, October 4.*

Maj. Emmett P. Varvel to Camp Dodge, Iowa, for duty.

Maj. Harry E. Smalley to Jefferson Barracks, Mo., for duty.

Capt. Emory C. Bardwell to Fort Monroe, Va., and coast artillery training center for duty.

Capt. Roy R. Newman to Indianapolis, Ind., aviation central repair depot, for duty.

Capt. Maximilian P. Bergeron to Camp Dodge, Iowa, for duty.

1st Lieut. Wm. F. Scheumann to East Potomac Park, Washington, for duty.

—*Army and Navy Register, October 11.*

Maj. Nathaniel Barnard to Fort Sheridan, Ill., general hospital 28.

Maj. James B. Harrington to Governors Island, N. Y., for duty.

Maj. Thomas J. Cassidy to Fort Sam Houston, Tex., for duty.

Maj. James L. Miller to Fort Leavenworth, Kan., for duty.

Majs. Benjamin J. Durham and Adolphus E. Worsham to Camp Dix, N. J., for duty.

Capt. Beverly M. Epes to Walter Reed General Hospital, D. C., for duty.

Capt. Adrian C. Ragan to Denver, Colo., general hospital 21, for duty.

Capt. Oscar W. Thompson to Camp Dodge, Iowa, for duty.

Capt. Leslie S. Harlan to Jefferson Barracks, Mo., for duty.

Capt. Ralph O. Leonard to Fort Slocum, N. Y., for duty.

Capt. Arthur C. Foard and First Lieut. Raymond E. Robb to Camp Dix, N. J., for duty.

First Lieut. Cecil R. Hillier to Fort McDowell, Calif., for duty.

First Lieut. Frank A. Crane to Aberdeen, Md., Proving Ground, for duty.

The following report by wire to commanding general Southern Department for duty: First Lieuts. Ralph J. Browne and James W. Young.

—*Army and Navy Register, October 18.*

Col. John H. Hess, at Chicago, reported to commanding general, Central Department, for duty as department dental surgeon.

Lieut. Col. Robert F. Patterson to Camp Dix, N. J., for duty.

Lieut. Col. Robert H. Mills to Boston for duty as department dental surgeon.

Lieut. Col. John A. McAllister, Jr., to Camp Meade, Md., for duty.

The following to duty at hospitals: Maj. Raymond W. Pearson, Hampton, Va., general hospital 43; Capts. Page P. A. Chesseh and Leon M. Muedekin, Walter Reed general hospital, D. C.; 1st Lieut. Robert C. Craven, Fort Sheridan, Ill., general hospital 28.

1st Lieut. Fay T. Bowen to Fort Sill, Okla., Air Service Flying School, Port Field, for duty.

1st Lieut. Lerel M. Bowman to Fort Leavenworth, Kan., disciplinary barracks for duty.

1st Lieut. Harvey H. Crosby to Fort Leavenworth, Kan., disciplinary barracks for duty.

—*Army and Navy Register, October 25*